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NATIONAL DAM SAFETY PROGRAM. LAKE MOR NE DAM (INVENTORY NUMBER--ETC(U)
SEP 79 J B STETSON DACW51-79-C-0001

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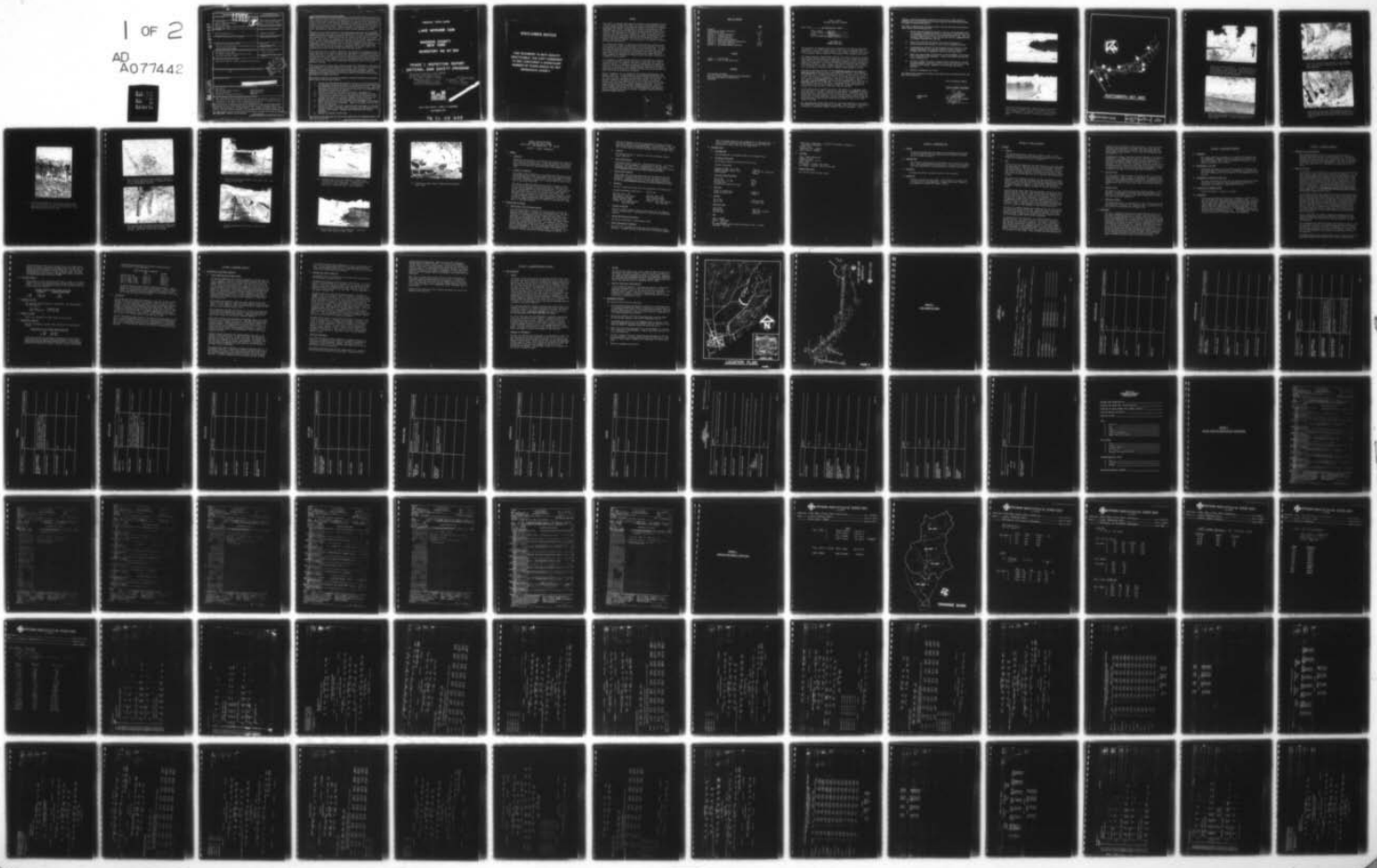

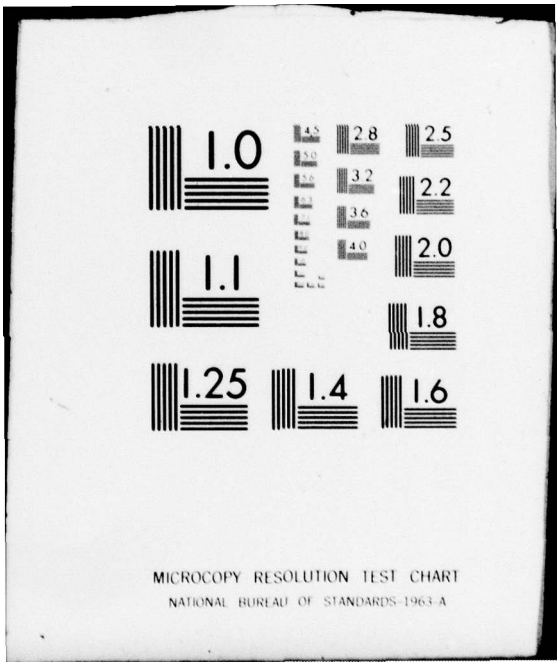
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Visual Inspection
Hydrology, Structural Stability
Lake Morain Dam
Madison County
Hamilton

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

The examination of documents and visual inspection of the dam and appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property. The dam, however, has a number of problem areas, which if not remedied, have the potential for developing into hazardous conditions.

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The visual inspection revealed water flowing in a ditch at the toe of the easterly abutment and wet areas on the downstream face of the easterly dam section. These areas should be monitored to determine the quantity of the flow and the extent of the wet areas. Periodic measurements should be taken to determine if these areas increase in size or flow. Test borings should be taken to determine the source of this flow. Remedial measures, as indicated as a result of this investigation, should be taken to prevent further damage to the dam.

Computations prepared according to the Recommended Guidelines for Safety Inspection of Dams establish the spillway capacity as 895 cfs. This capacity is 8-1/2 percent of the Probable Maximum Flood and 47.6 percent of the 1/2 Probable Maximum Flood. The PMF and 1/2 PMF are 10,552 cfs and 1,881 cfs respectively. The spillway is inadequate to pass the 1/2 PMF without overtopping the dam. Based on the Guidelines criteria, the dam is considered to have a seriously inadequate spillway since the earthen embankment could erode and fail when overtopped by the 1/2 PMF flow. A dam break analysis determined that flood flows in the Village of Hamilton, downstream of the dam, would be increased by two feet for the 1/2 PMF and 4 feet for the PMF.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to connote the same degree of emergency as would be associated with an "unsafe" classification applied for a structural deficiency. It does mean that there appears to be a serious deficiency in the spillway capacity and if a severe storm were to occur, overtopping and failure of the dam could take place, significantly increasing the hazard to loss of life downstream of the dam.

The investigations defined above should be undertaken immediately to determine the appropriate mitigating measures to be taken. Within 2 years of the date of notification, appropriate remedial measures should be completed. In the interim, a detailed emergency operation plan and warning system should be developed and around-the-clock surveillance should be provided during periods of unusually heavy precipitation.

The visual inspection and screening analysis revealed additional deficiencies which require the following action:

1. Perform detailed hydrologic/hydraulic analysis of the drainage basin to accurately determine the effect of the specific characteristics of the watershed on the outflow of the Probable Maximum Flood. Make the necessary modifications in the spillway structure to accommodate the 1/2 Probable Maximum Flood outflow.
2. Monitor the quantity and further investigate the source of under/through-the-dam seepage in the easterly embankment section.
3. Investigate the condition of the abandoned outlet structure in the easterly embankment and undertake remedial measures necessary to mitigate the effect of dangerous conditions which may exist.
4. Repair the riprap along the waterline of the embankment to eliminate local sloughing of the embankment. Remove tree stumps from the riprap at the waterline.
5. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference.
6. Develop an emergency action plan.

The remedial work necessary for these items should also be completed within two years of notification.

CHENAGO RIVER BASIN

LAKE MORAINE DAM

MADISON COUNTY
NEW YORK

INVENTORY Nº NY 354

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Lake Moraine Dam (Inventory Number NY-354).
Chenago River Basin, Madison County,
New York. Phase I Inspection Report,

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(11) 28 Sep 79

(10) John B. /Stetson

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NEW YORK DISTRICT CORPS OF ENGINEERS

SEPTEMBER 1979

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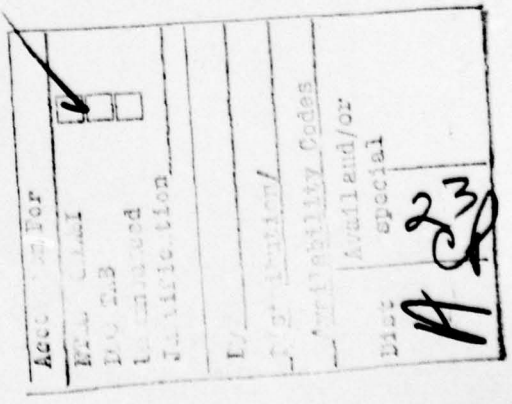
PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam Lake Moraine Dam, NY354

State Located New York
County Located Madison
Stream Payne Brook
Date of Inspection August 9, 1979

ASSESSMENT OF GENERAL CONDITIONS

The examination of documents and visual inspection of the dam and appurtenant structures did not reveal conditions which constitute an immediate hazard to human life or property. The dam, however, has a number of problem areas, which if not remedied, have the potential for developing into hazardous conditions.

The visual inspection revealed water flowing in a ditch at the toe of the easterly abutment and wet areas on the downstream face of the easterly dam section. These areas should be monitored to determine the quantity of the flow and the extent of the wet areas. Periodic measurements should be taken to determine if these areas increase in size or flow. Test borings should be taken to determine the source of this flow. Remedial measures, as indicated as a result of this investigation, should be taken to prevent further damage to the dam.

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The visual inspection and screening analysis revealed additional deficiencies which require the following action:

1. Perform detailed hydrologic/hydraulic analysis of the drainage basin to accurately determine the effect of the specific characteristics of the watershed on the outflow of the Probable Maximum Flood. Make the necessary modifications in the spillway structure to accommodate the 1/2 Probable Maximum Flood outflow.

2. Monitor the quantity and further investigate the source of under/through-the-dam seepage in the easterly embankment section.

3. Investigate the condition of the abandoned outlet structure in the easterly embankment and undertake remedial measures necessary to mitigate the effect of dangerous conditions which may exist.

4. Repair the riprap along the waterline of the embankment to eliminate local sloughing of the embankment. Remove tree stumps from the riprap at the waterline.

5. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference.

6. Develop an emergency action plan.

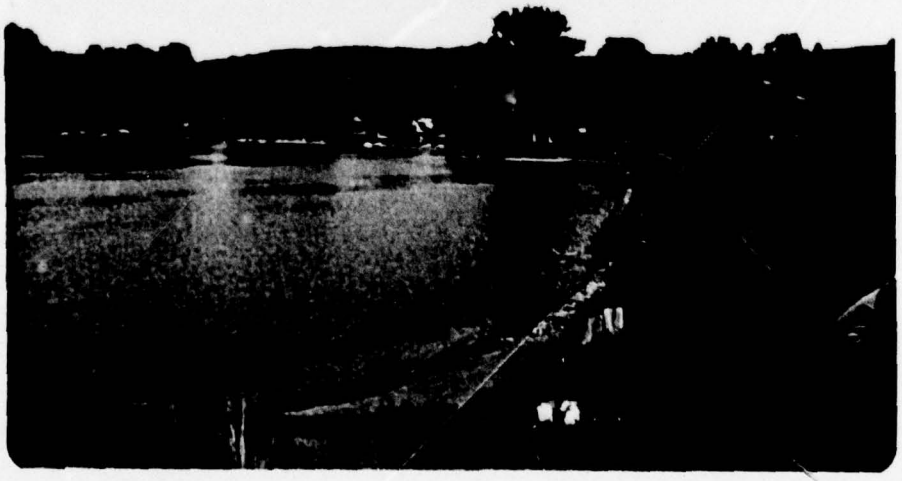
The remedial work necessary for these items should also be completed within two years of notification.

Dale Engineering Company

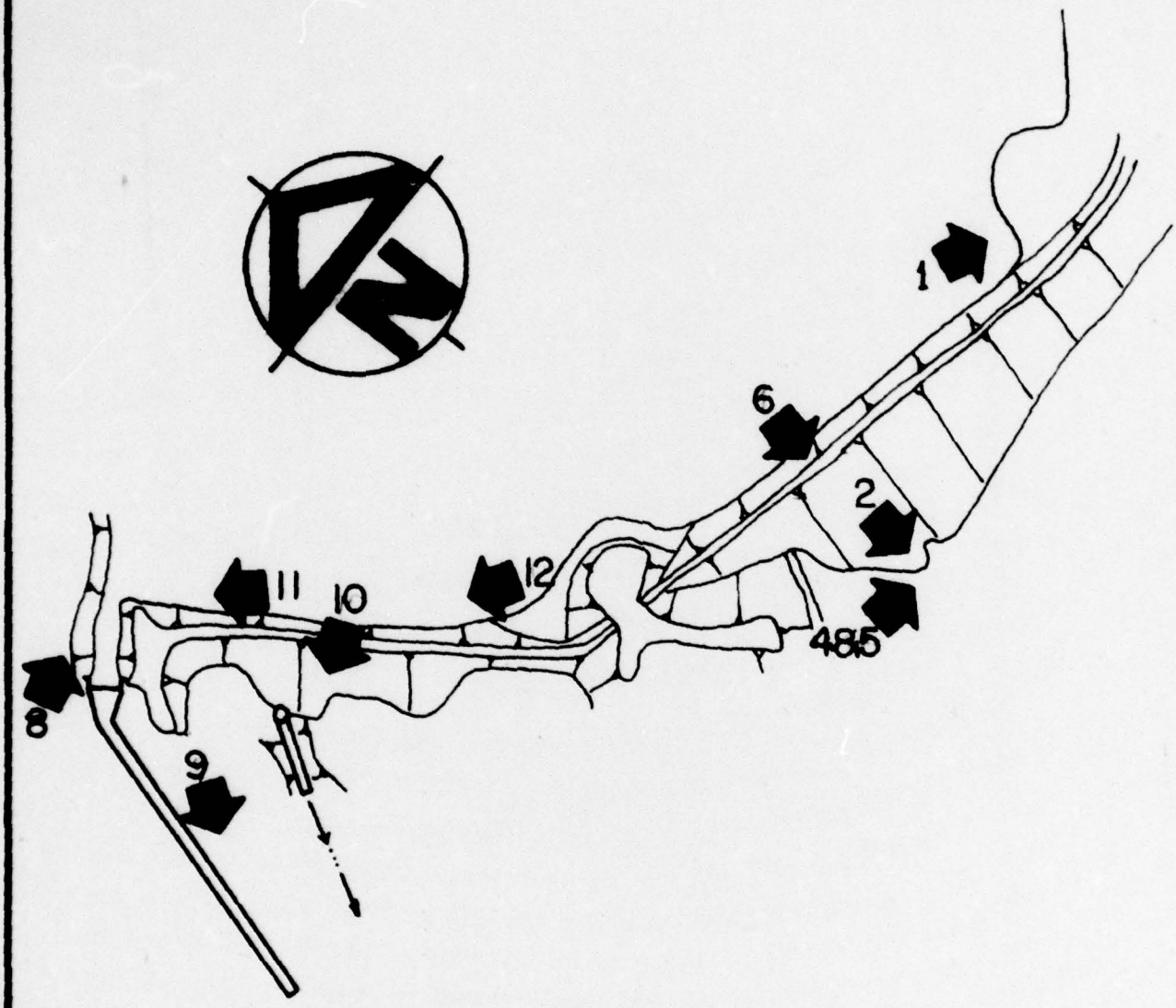
John B. Stetson, President

Approved By:
Date:

Col. Clark H. Benn
New York District Engineer
28 Sept 79

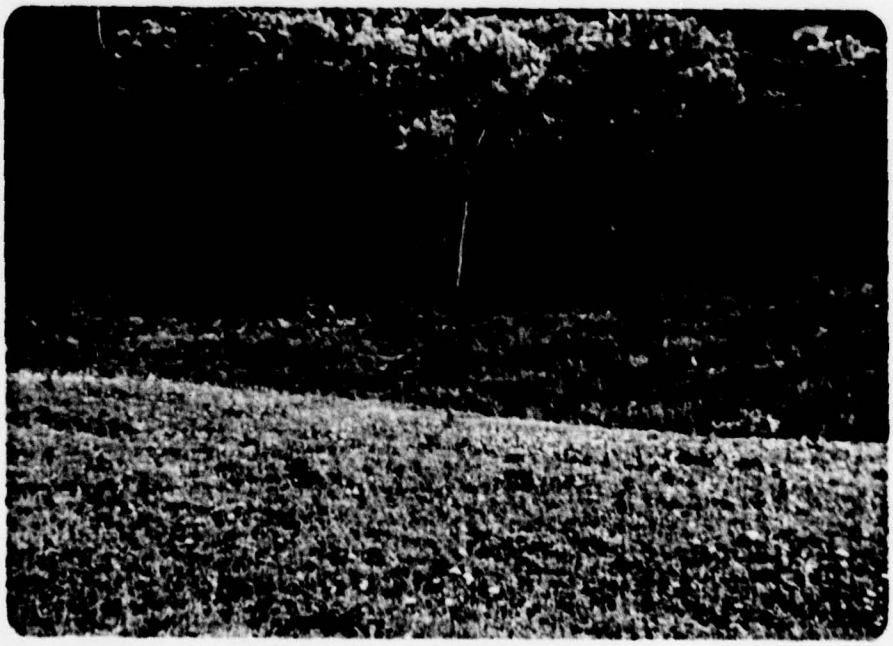


Overview of Lake Moraine Dam. These photographs were taken from a natural abutment located in the center of the dam. The top photograph is of the west section; the bottom photograph is of the east abutment. The dam was constructed in 1836.



PHOTOGRAPH KEY MAP

1. Summer and winter residences at the east end of the reservoir. These structures are located at an elevation below the top of the dam. Some flow could divert around the dam between the structures located in the left portion of this photograph.

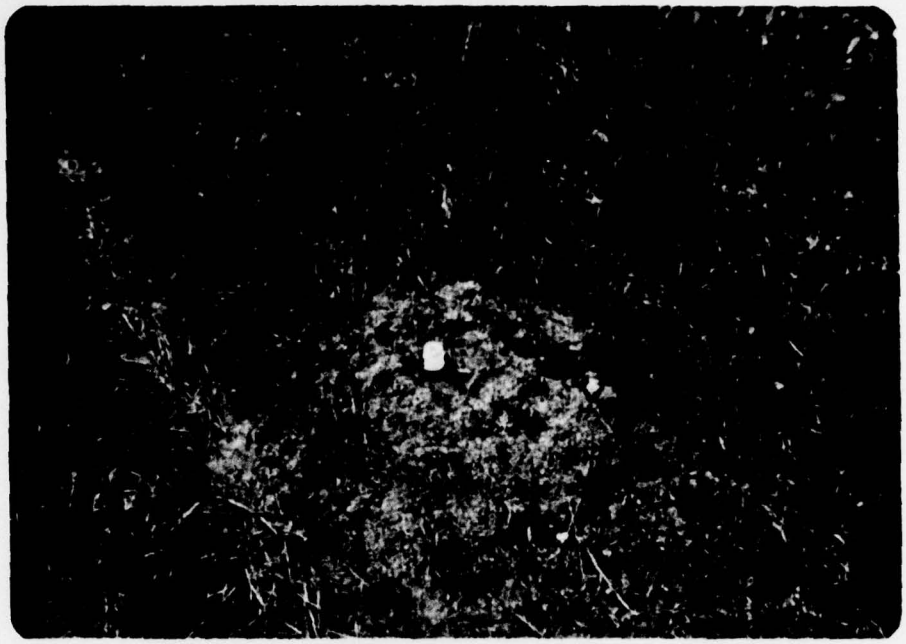


2. View of the area below toe of the east section of dam. Small discharge channel in center of picture is no longer used.

3. Close-up of stone drainage channel at toe of embankment. The toe area is overgrown with brush and grass type vegetation.

4. Close-up of wet area with slight amounts of seepage coming through toe of the east section abutment. This area is located near the center of the east embankment section.

5. Inspection of another wet area on east section of dam at its west abutment at a distance one-third the way down from the top of the dam. The soft/wet area is between 200-500 square feet in area.



6. One of the two observation wells placed in the dam. Each of these observation wells is located in the center of the embankment sections.

7. Hole location west dam section, less the 1/2 cubic yard in size. A number of animal holes have been located in the area. The origin of this hole is unknown.

8. Note spillway entrance channel at west end of dam. The channel is not lined.

9. Spillway necks down from 35 feet to this 10 foot section.

10. Gatehouse where flows are regulated to augment flow into New York State Barge Canal. A home below the dam can be seen in this photograph. The Village of Hamilton is located less than 2 miles downstream.

11. Riprap on the dam is in poor condition. Large tree stumps remain along the water's edge.

12. Close-up of riprap shows irregularity and generally small rocks.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM - LAKE MORAINE DAM ID# - NY 354

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

Authority for this report is provided by the National Dam Inspection Act, Public Law 92-367 of 1972. It has been prepared in accordance with a contract for professional services between Dale Engineering Company and The New York State Department of Environmental Conservation.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the existing condition of the Lake Moraine Dam and appurtenant structures, owned by the New York State Department of Transportation, and to determine if the dam constitutes a hazard to human life or property and to transmit findings to the State of New York.

This Phase I inspection report does not relieve an Owner or Operator of a dam of the legal duties, obligations or liabilities associated with the ownership or operation of the dam. In addition, due to the limited scope of services for these Phase I investigations, the investigators had to rely upon the data furnished to them. Therefore, this investigation is limited to visual inspection, review of data prepared by others, and simplified hydrologic, hydraulic and structural stability evaluations where appropriate. The investigators do not assume responsibility for defects or deficiencies in the dam or in the data provided.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

The Lake Moraine Dam is an earth fill structure which impounds the waters of Payne Brook, a tributary of the Chenango River. The dam is composed of two separate sections which abut near the center at a natural hill. The westerly section is 800 feet long and has a maximum height of approximately 56 feet. The easterly section is 600 feet long with a maximum height of about 36 feet. The overall length of the dam is approximately 1400 feet. The emergency spillway is located near the west abutment of the dam. A short earthen approach channel connects the 35 foot wide, broad crested weir masonry spillway to the impoundment. The spillway discharges through a 10 foot wide masonry channel into the receiving stream. This channel is constructed in original ground near the west abutment of the dam. A

gate house located at the toe of the westerly section of the dam controls discharge from the impoundment into Payne Brook. Flows from Payne Brook are then discharged through a canal into Oriskany Creek. Two, 18 inch pipes are controlled by gate valves in the gate house.

b. Location

The Lake Moraine Dam is located in the Town of Madison, Madison County, New York.

c. Size Classification

The maximum height of the dam is approximately 57 feet. The storage capacity of the impoundment is approximately 1,700 acre feet. Therefore, the dam is in the Intermediate Size Category as defined by The Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification

Payne Brook, the receiving stream from the Lake Moraine Dam flows through the Village of Hamilton and across the campus of Colgate University. Therefore, the dam is in the High Hazard Category as defined by The Recommended Guidelines for Safety Inspection of Dams.

e. Ownership

The dam is owned by the New York State Department of Transportation.

Waterway Maintenance Subdivision:

New York State - DOT
Main Office - State Campus
1220 Washington Avenue
Albany, New York 12232
Director - Mr. Joseph Stellato
(518) 457-4420

Region Two:

New York State - DOT
State Office Building
Utica, New York 13501
Engineer - Mr. Frank Jennings
(315) 797-6120

f. Purpose of the Dam

The dam is used to regulate flows in Payne Creek for flow augmentation in the Barge Canal. Lake Moraine is also used for recreational purposes.

g. Design and Construction History

The dam was constructed in approximately 1836.

h. Normal Operational Procedures

The facility is operated by the New York State Department of Transportation. The main function of the facility is to provide adequate

flows in Oriskany Creek for flow augmentation in the Barge Canal. In order to fulfill this function, the valves in the gate house are manipulated to control the flow into Payne Brook.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Lake Moraine Dam is 8.21 square miles.

b. Discharge at Dam Site

No discharge records are available for this site.

Computed discharges:

Ungated spillway, top of dam	1,070 cfs
Ungated spillway, design flood	1,640 cfs est. from plans
Gated drawdown	Unknown

c. Elevation (Feet above MSL)

Top of dam	1215.5
Maximum pool - 1/2 PMF	1217.0
Spillway crest	1211.0
Stream bed at centerline of dam	1168

d. Reservoir

Length of maximum pool	10,500+ ft
Length of normal pool	9,000± ft

e. Storage

Top of dam	2,850 acre feet
Normal pool	1,717±acre feet

f. Reservoir Area

Top of dam	260± acre
Maximum pool	265± acre (1/2 PMF)
Spillway pool	250± acre

g. Dam

Type - Earthen
Length - 1400+ feet
Height - 57± feet
Freeboard between normal reservoir and top of dam - 4.5 feet
Top width - 10± feet

Side slopes - Downstream - 3 vertical/1 horizontal, Upstream - 2 vertical/2.5 horizontal
Zoning - None
Impervious core - Unknown
Grout curtain - Unknown

h. Spillway

Type - Broad crested weir
Length - 35 feet
Crest elevation - 1211.0
Gates - N/A
U/S channel - Earthern side slopes
D/S channel - Concrete lined 9.8 feet wide

i. Regulating Outlets

Two, 18 inch pipes with gate valves

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design information was available for the evaluation of this dam. A survey of the dam site was conducted by Dale Engineering Company and is included as Figure 2.

2.2 CONSTRUCTION

No information regarding the construction of this facility was available. Sub-surface exploration logs taken in July of 1979 by the New York State Department of Transportation are included in the report.

2.3 OPERATION

No Operation Manual is known to exist for this structure.

2.4 EVALUATION

The data available for this report is not adequate to perform a detailed analysis of the embankment. However, the visual inspection was adequate to complete this Phase I report.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The Lake Moraine Dam was inspected on August 9, 1979. The Dale Engineering Company Inspection Team was not accompanied by a representative of the Owner on the this inspection.

b. Dam

At the time of the inspection, the water elevation in the impoundment was approximately 2 feet below the crest of the emergency spillway. The east abutment of the dam terminates in an area that is built-up with summer cottages. The ground elevations in this area is lower than the top of dam elevations. This would allow high water flows to pass around the dam and down parallel to the toe into the receiving stream.

The riprap on the easterly section of the dam was generally in poor condition. Many areas have sloughed away and large trees which have recently been cut from the face of the dam have displaced the riprap. The top of the dam is irregular in both vertical and horizontal alignment, although no general settlement of the dam structure was noted.

A poorly defined stone lined ditch runs parallel to the toe of the westerly portion of the dam. Some flowing water was observed in this ditch, although no specific source for this water was found. The inspection took place after a long spell of dry weather, so that it is unlikely that surface run-off would have caused this amount of flow. An abandoned outlet structure is located near the center of the easterly portion of the dam. There is no information regarding this structure. Water in the abandoned discharge channel near the outlet from this structure shows evidence of iron oxide precipitation.

Two areas of suspected seepage were discovered near the west abutment of the easterly section of the dam. These areas were on the face of the dam at approximately 1/2 of the height of the dam. No flowing water was noted in these areas, however, definite evidence of moisture and spongy ground conditions were discovered.

The westerly section of the dam is in a similar condition to the easterly section. The crest of the top of the dam is irregular in both vertical and horizontal alignment. The riprap at the water's edge has been displaced by recently cut trees at the water's edge. The irregularities in the alignment however, are not attributed to general subsidence of the dam embankment. The dam has been opened to public travel and many footpaths are in evidence, both along the top of the dam and on the slopes. These footpaths have been worn bare of

vegetation and are potential areas for erosion. A small localized settlement was discovered in the downstream face of the dam just above the controlled outlet structure. This settlement indicates displacement of approximately 1/2 of a cubic yard of material (See Photograph No. 7.).

The emergency spillway, located at the west abutment of the westerly embankment, is in generally good condition. The structure is constructed of masonry and shows no signs of severe deterioration. A short approach channel extends from the spillway crest to the impoundment. At the time of this inspection, water was standing in the approached channel. Observation wells have recently been installed in the center of both the easterly and westerly embankments. These piezometers are shown on the survey map (See Figure No. 2.).

c. Control Outlet

The main control outlet structure is located at the toe of the westerly embankment. Flows from two, 18 inch pipes, are controlled by valves into the discharge channel, Payne Brook. An abandoned outlet located in the easterly section of the dam is presently inoperative. Standing water near the outlet shows signs of iron oxide precipitation.

d. Reservoir Area

The reservoir area is fully built-up with summer cottages. The impoundment is approximately 9,000 feet long and approximately 1700 feet wide at its widest point. There are no known areas of bank instability around this impoundment.

e. Downstream Channel

The downstream channel is constructed for a short distance below the controlled outlet structure as a concrete flume. No evidence of recent erosion is noted below the discharge flume.

3.2 EVALUATION

The visual inspection indicates that seepage problems may exist on the easterly embankment section of the dam. Both the stone ditch area near the east abutment of this section and the wet spots on the face of the embankment near the west abutment should be investigated to determine the source of this moisture. An investigation should be undertaken to determine the condition of the abandoned outlet structure through the easterly section. Remedial work should be taken if this condition could endanger the stability of the structure. The riprap on both the east and west sections of the dam should be repaired and stumps along the waterline should be removed. The source of the problem causing the localized settlement in the downstream face of the dam just above the outlet structure should be investigated and remedial measures taken to rectify this problem.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The primary operational procedure is to control the discharge from the impoundment to augment flows for navigational purposes in the Barge Canal System. The valves in the outlet structure are manipulated to accomplish this function.

4.2 MAINTENANCE OF THE DAM

Maintenance and operation of the dam is controlled by the New York State Department of Transportation. Maintenance is undertaken annually and includes cutting of the material on the downstream face of the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

The gates controlling the flow into the downstream channel are under the control of the New York State Department of Transportation. These gates are presently in operational condition.

4.4 DESCRIPTION OF WARNING SYSTEM

No warning system is in effect at present.

4.5 EVALUATION

The dam and appurtenant structures are inspected at regular intervals by the New York State Department of Transportation. It is evident from the visual inspection that maintenance has been undertaken in the recent past. However, the presence of large stumps at the water's edge and evidence of recent cutting on the face of the dam indicate that this maintenance has not always been done. The presence of the two observation wells in the embankment indicate that the Department of Transportation is presently undertaking investigations as to the source of seepage through the embankment.

SECTION 5 - HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE AREA CHARACTERISTICS

The Lake Moraine Dam is located in the south center portion of Madison County two miles east of Hamilton, New York. The dam has a drainage area of 8.21 square miles. Located just east of Hamilton, a diversion structure below the dam regulates flows into the Oriskany Creek Basin, from which flow augmentation is provided for the Barge Canal System west of Utica. The reservoir surface area is 250 acres.

5.2 ANALYSIS CRITERIA

The purpose of this investigation is to evaluate the dam and spillway with respect to their flood control potential and adequacy. This has been assessed through the evaluation of the Probable Maximum Flood (PMF) for watershed and the subsequent routing of the flood through the reservoir and the dam's spillway system. The PMF event is that hypothetical flow induced by the most critical combination of precipitation, minimum infiltration loss and concentration run-off of a specific location that is considered reasonably possible for a particular drainage area. Since the dam is in the Small Dam Category and is a High Hazard, the Recommended Guidelines for Safety Inspection of Dams (Ref. 1) require that the spillway be capable of passing one-half the Probable Maximum Flood.

The hydrologic analysis was performed using the unit hydrograph method to develop the flood hydrograph. Due to the limited scope of this Phase I investigation, certain assumptions, based on experience and existing data were used in this analysis and in the determination of the dam's spillway capacity to pass the PMF. In the event that the dam could not pass the 1/2 Probable Maximum Flood without overtopping, an additional analysis is to be performed on potential dam failure if the dam is designated as a High Hazard Classification. This process was done with the concept that if the dam was unable to satisfy this criteria, further refined hydrologic investigations would be required.

The U.S. Army Corps of Engineers' Hydrologic Engineering Center's Computer Program HEC-1 DB using the Modified Puls Method of flood routing was used to evaluate the dam, spillway capacity, and downstream hazard.

Unit hydrographs were defined by Snyder coefficients, Ct and Cp. The Ct values were 2.0 and 3.0 for steeply sloped and flat run-off areas respectively. Cp was set at 0.625. The drainage area was divided into sub-areas according to the slope of the terrain. Run-off, routing and flood hydrograph combining was then performed as inflow to the reservoir.

The Probable Maximum Precipitation (PMP) was 19.5 inches according to Hydrometeorological Report (HMR #33) for a 24-hour duration, 200

square mile basin, while loss rates were set at 1.0 inches initial abstraction and 0.1 inches/hour continuous loss rate. The loss rate function yielded 83 percent run-off from the PMF. The PMF inflow hydrograph was 11,467 and the 1/2 PMF inflow was 5,760. The large storage capacity of the reservoir reduced these flows to 10,522 cfs for the PMF and 1,881 cfs for the 1/2 PMF.

5.3 SPILLWAY CAPACITY

The spillway is a weir type structure 35 feet in length. A spillway coefficient of 3.2 was assigned for the spillway rating curve development. The overall discharge capability of the spillway at the top of dam elevation is 895 cfs.

SPILLWAY CAPACITY WITHOUT BRIDGE BELOW DAM

	Discharge	Capacity as % of PMF
PMF	10,552 cfs	8.5%
1/2 PMF	1,881 cfs	47.6%

5.4 RESERVOIR CAPACITY

The reservoir storage capacity is given below. This was estimated for USGS mapping.

Top of Dam	2,980 Acre Feet
Crest of Spillway	1,717 Acre Feet

5.5 FLOODS OF RECORD

There is no information on water levels at the dam site.

5.6 OVERTOPPING POTENTIAL

The HEC-1 DB analysis indicates that the dam will be overtopped as follows:

OVERTOPPING IN FEET WITHOUT BRIDGE BELOW DAM

PMF	1.86 Feet
1/2 PMF	0.25 Feet

A dam break analysis was performed to determine the significance of various types of dam breaks on downstream hazards. The residence immediatley below the embankment would certainly be in the floodway and would be inundated by a break in the dam. The main hazard area

analyzed below the dam was the Village of Hamilton which is approximately 2 miles downstream.

FLOOD ELEVATIONS IN HAMILTON

	PMF	1/2 PMF
Dam Does Not Fail	1125.9 ft.	1122.0 ft.
250 Ft. Break In Dam	1129.9 ft.	1124.0 ft.
500 Ft. Break in Dam	1129.0 ft.	1124.0 ft.
750 Ft. Break in Dam	1128.7 ft.	1124.0 ft.
1000 Ft. Break in Dam	1128.7 ft.	1124.0 ft.

The above elevations were estimated from USGS quad sheets. These elevations are not exact and their significance is in the difference between the elevations for flood levels with and without the dam break. The maximum difference determined by the analysis was 4 feet for the PMF and 2 feet for the 1/2 PMF.

5.7 EVALUATION

The spillway has been determined inadequate to pass the 1/2 PMF Probable Maximum Flood without overtopping of the dam. Based on the Corps of Engineers' criteria, the dam is considered to have a seriously inadequate spillway since the earthen embankment could erode and fail when overtopped. A dam break analysis determined that flood flows in the Village of Hamilton, downstream of the dam, would be increased by 2 feet for the 1/2 PMF and 4 feet for the PMF. A residence immediately below the dam would also be inundated by a dam failure. Other structures are likely to be located in the floodway between the dam and the Village.

The HEC-1 DB model has determined that the dam would be overtopped by 0.25 feet. A detailed hydrologic analysis of the basin should be performed to more accurately determine the site specific characteristics of the watershed. This investigation should take into consideration all upland storage areas in the watershed to determine the effect of attenuation into the dam site.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations and Data Review

This earthen embankment dam, extending generally in an east-west direction, appears to consist of two constructed segments (an east and a west embankment) which have abutted a natural hill area near the present center of the existing (total) dam. This dam is an old facility, and design/construction plans apparently do not exist to provide information on pre-construction conditions or the materials and methods of construction. The slopes of the upstream and downstream faces vary considerably between different sections of the dam, and there is evidence of some past localized sloughings, erosion and through-the-dam seepage, but as a total structure the dam shows no indication of having experienced serious movements or other structural instability.

The upstream and downstream slopes have been cleared of brush and trees relatively recently. Some tree stumps from the large trees cut remain. A small number of holes into the embankment, typical of that resulting from burrowing animals, exist.

Riprap apparently had been provided for all the dam's upstream slope (up to about the expected wave elevation) but its present condition varies from fairly good to non-existant. Embankment erosion from wave and ice action is occurring at numerous locations.

Water flow believed to be through-the-dam seepage occurs at the downstream toe of the easterly dam section. Some damp and spongy areas also were noted at higher elevations on the downstream slope of this easterly segment. Two capped observation well pipes, recently installed by the State Department of Transportation, are in place and extend through the top of the embankment, presumably to obtain information on water levels in the embankment to relate to the noted seepage conditions.

Campsites occupy the western and eastern shores of the lake. The property on the western shore is generally higher than the dam and emergency spillway located at the dam's west end. The property on the east shore adjacent to the dam's east abutment is slightly lower than the top of the dam and appears susceptible to flooding for a situation where the emergency spillway could not rapidly dispose of the lake's excess flood water.

The concrete and masonry emergency spillway and discharge chute is in serviceable condition. A small brick building (locked at the time of the inspection) located at the downstream toe near the center of the dam's western segment apparently houses the lake's outlet structure controls. A masonry discharge channel extending from this building

to a natural channel further downstream is also in serviceable condition. A stone arch tunnel existing at the downstream toe of the dam's eastern segment appears to be in good condition but the tunnels origin and function were not determined.

b. Geology and Seismic Stability

Lake Moraine Dam is located within the southern New York section of the Appalachian Plateaus Province.

No bedrock was observed in the vicinity of the dam site. It is not known if the dam foundation or abutments are in contact with bedrock which, in this area, are mainly shales with some limestones of the Marcellus Formation of Middle Devonian age. Bedding in the area would be close to horizontal, dip less than 1° to the south which is the general regional dip.

The dam is sited in a drift-filled glacial-trough. According to Cadwell, 1972, p. D-2, glacial drift in valleys in the region ranges between 50 and 250 feet thick. Drift in the valley downstream of the dam is considered to be of deltaic origin and consists of sorted and stratified sands and gravels. The east and west valley walls to which the dam is in contact are kame deposits, also sorted and stratified sands and gravels. The knob in the central part of the dam is of glacial till, unsorted and unstratified glacial debris. This knob represents debris left behind by a stagnant block of ice. It is probable that this knob is a topographic high of a valley moraine which cut across the valley and the fill for the dam was placed atop that till. Till is considered to be relatively impermeable, whereas deltaic and kame deposits are generally permeable.

No known faults exist in the vicinity of the dam. According to the Brittle Structures Map, a lineament (which suggests a possible fault line) is present 2-1/2 miles northwest of the dam. The lineament trend is northeast-southwest. Only minor earthquake activity has occurred in this region. The most severe, V-VI on the Modified Mercalli scale, occurred in 1840 in the Utica area, about 29 miles northeast of the dam site. The closest, 21 miles to the northeast, occurred in 1930 and had an intensity of only II on the Modified Mercalli scale.

c. Stability Evaluation

As a total structure, the dam embankment is presently structurally stable with no imminent failure zones of a proportion dangerous to the structure being indicated. However, localized erosion and sloughing is likely along some usptream faces where loss of riprap and/or past erosion has occurred.

The under-the-dam and through-the-dam seepage noted is a condition which could have an affect on the structure. The causes of such

seepage should be determined. (Boring logs for the recently installed observation wells (Appendix - B) indicate the embankments include layers or lenses of soil having a high granular content; such materials could have a high permeability and be the path of through-the-dam seepage.) In areas where investigation indicates the seepage possesses a potential for causing its embankment to lose stability, means to have the seepage condition corrected or controlled should be undertaken.

Most of the upstream slope in the vicinity of the zone affected by lake water requires some rehabilitation and repair: eroded areas should be stabilized by the addition of crushed rock or gravel materials, and riprap for the entire upstream length should be improved to the condition where it will adequately protect embankment material from erosion.

Animal burrows should be filled to reduce the danger for erosion and seepage at such locations.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

The Phase I visual inspection of the Lake Moraine Dam did not indicate conditions which constitute an immediate hazard to human life or property. The visual inspection indicates that seepage through the dam or under the dam may exist on the easterly embankment section of the dam. Both the stone ditch area near the east abutment and the wet spots on the face of the embankment indicate the possibility of through-the-dam seepage. The riprap on both the east and west sections of the dam is in poor condition and should be localized. Sloughing has occurred in many areas as well as displacement of the riprap material by recently cut tree growth at the waterline. The abandoned outlet structure through the westerly embankment section shows evidence of leakage and iron precipitate is in evidence of the channel downstream from the outlet of the structure. Localized settlement in the downstream face of the westerly embankment section is noted in the visual inspection.

The hydrologic/hydraulic analysis indicates that the spillway is inadequate to pass the 1/2 Probable Maximum Flood without overtopping of the dam. Based on the Corps of Engineers' criteria, the dam is considered to have a seriously inadequate spillway since it is an earthen embankment which could erode when overtopped.

As a total structure, the dam embankment is presently structurally stable with no imminent failure zones of a proportion dangerous to the structure being indicated. However, localized erosion and sloughing along some of the upstream faces is likely to continue. A localized seepage discovered in the visual inspection should be closely monitored and the causes of such seepage should be investigated. Localized settlements and animal burrows should be filled to reduce the danger of erosion and seepage at such locations.

b. Adequacy of Information

The dam is an old facility constructed in approximately in 1836. Design and construction plans apparently do not exist to provide further information on preconstruction conditions or the materials and methods of construction. Recent boring logs indicate the embankments include layers or lenses of soil having a high granular content and such materials could have high permeability and be a path of through-the-dam seepage. The available information is adequate for this Phase I Inspection Report.

c. Urgency

The deficiencies noted in the visual inspection while not serious at the present time could increase in severity during an extreme rainfall event or become progressively worse if uncorrected. Therefore, the investigations recommended below should be undertaken immediately and should be completed within one year. Remedial words defined by these investigations should be completed within 2 years.

d. Need for Additional Investigations

Further hydrologic/hydraulic investigations should be undertaken to accurately determine the site specific characteristics of the watershed and their effect on the outflow from the impoundment during extreme rainfall events. Additional investigations should be undertaken to determine the source of under/through-the-dam seepage on the easterly embankment section.

7.2 RECOMMENDED MEASURES

The following steps should be undertaken:

1. Perform detailed hydrologic/hydraulic analysis of the drainage basin to accurately determine the effect of the specific characteristics of the watershed on the outflow of the Probable Maximum Flood. Make the necessary modifications in the spillway structure to accommodate the 1/2 Probable Maximum Flood outflow.

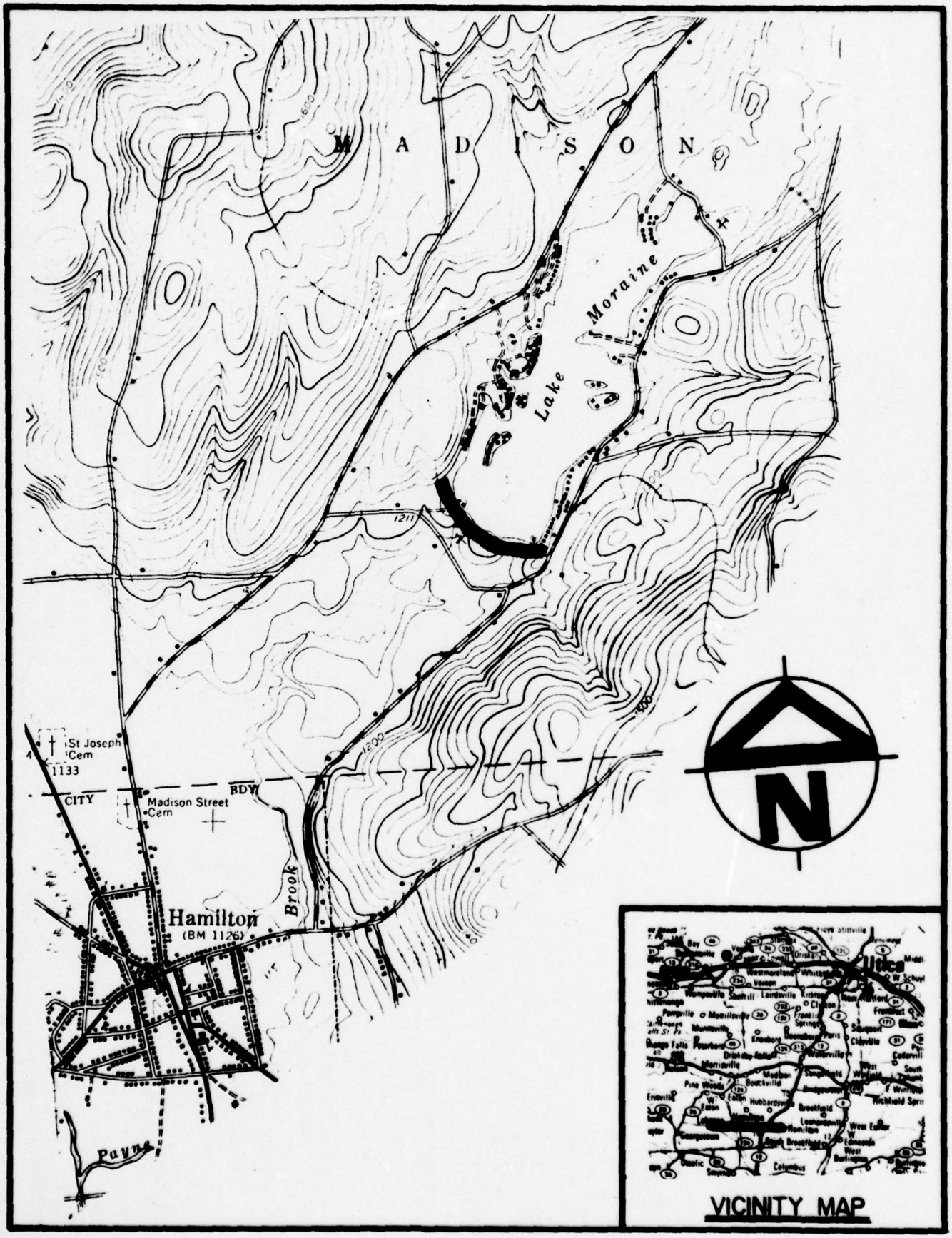
2. Monitor the quantity and further investigate the source of under/through-the-dam seepage in the easterly embankment section.

3. Investigate the condition of the abandoned outlet structure in the easterly embankment and undertake remedial measures necessary to mitigate the effect of dangerous conditions which may exist.

4. Repair the riprap along the waterline of the embankment to eliminate local sloughing of the embankment. Remove tree stumps from the riprap at the waterline.

5. Provide a program of periodic inspection and maintenance of the dam and appurtenances, including yearly operation and lubrication of the reservoir drain system. Document this information for future reference.

6. Develop an emergency action plan.



LOCATION PLAN

FIGURE 1

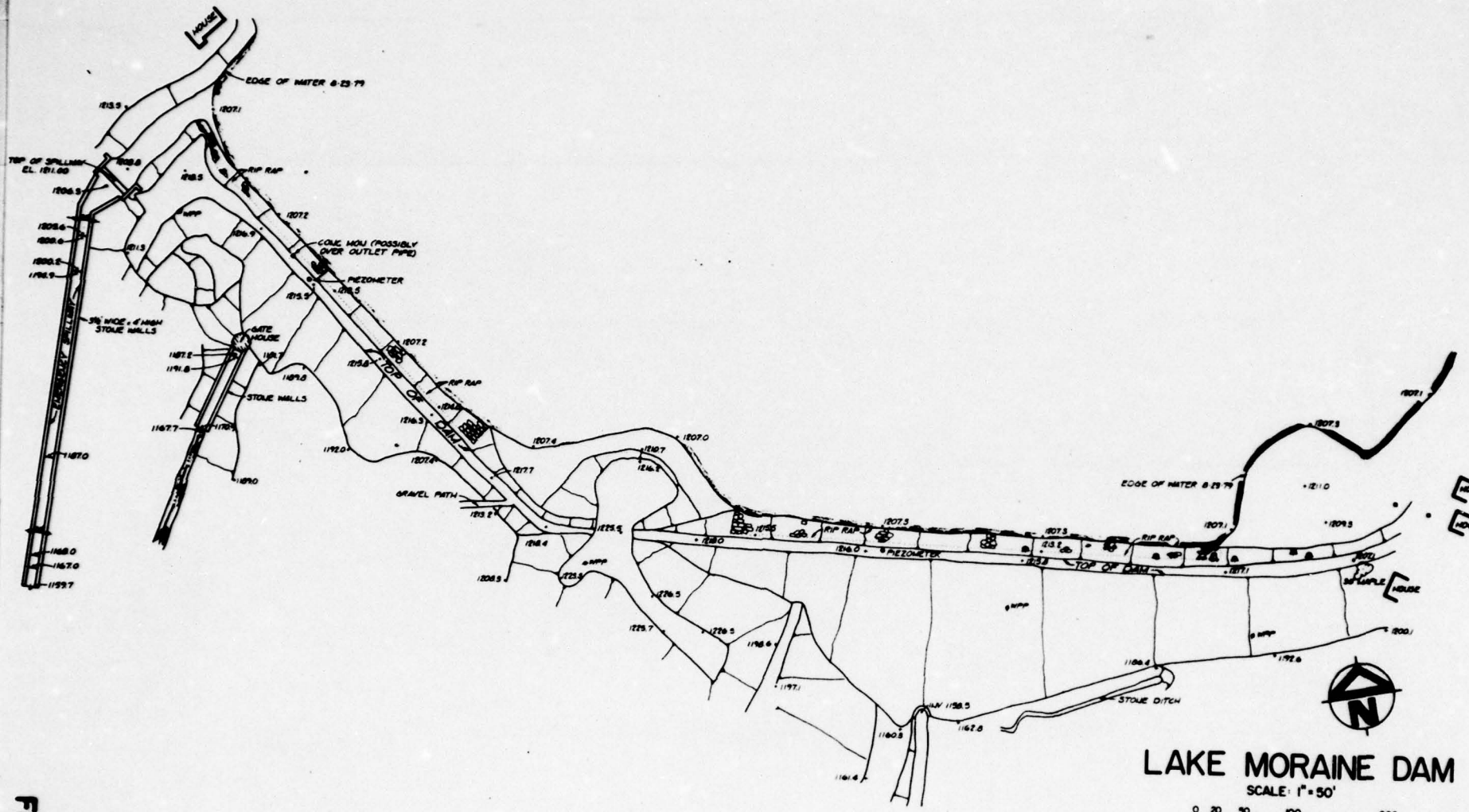

EDGE OF WATER 8-23-79
TOP OF SPILLWAY EL. 1211.60
RIP RAP
COVE MORAINE (POSSIBLY OVER OUTLET PIPE)
PIEZOMETER
5' WIDE x 4' HIGH STONE WALLS
GATE HOUSE
STONE WALLS
TOP OF DAM
GRAVEL PATH
EDGE OF WATER 8-23-79
RIP RAP
PIEZOMETER
TOP OF DAM
HOUSE
STONE DITCH
N
LAKE MORAINE DAM
SCALE: 1" = 50'
0 20 50 100 200
SCALE IN FEET
STETSON • DALE
BANKERS TRUST BUILDING · UTICA · NEW YORK 13501

FIGURE 2

APPENDIX A

FIELD INSPECTION REPORT

CHECK LIST
VISUAL INSPECTION

PHASE 1

Name Dam Lake Moraine Dam County Madison State New York ID # NY354

Type of Dam Earthen Hazard Category High

Date(s) Inspection August 9, 1979 Weather Sunny Temperature 80's

Pool Elevation at Time of Inspection 2 feet below crest M.S.L. Tailwater at Time of Inspection ---

Inspection Personnel:

N. F. Dunlevy	Dale Engineering	
F. W. Byszewski	Dale Engineering	
F. D. McCarthy	Dale Engineering	
W. Mushatt	Dale Engineering	
J. A. Gomez	Dale Engineering	

N. F. Dunlevy Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL & HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAGE OF RECORDER	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Western dam section behind gate house is a hole which is from sloughing or animals. Also some sloughing/erosion of embankments along emergency spillway approach channel.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Dam is irregular due to construction methods in 1836.	
RIPRAP FAILURES	Riprap is not adequate. The upstream face is irregular, riprap too small, and not enough. Ice has moved riprap about.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Softness at toe along drainageway on eastern section. Seepage found at one location midway along toe. The western abutment of eastern section has softness 1/3 way down from top of dam.	
ANY NOTICEABLE SEEPAGE	See above.	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR Masonry Weir	Weir in useable condition. Stone Masonry in good condition.	
APPROACH CHANNEL	Not lined. Silted somewhat. Side slopes in poor condition due to sloughing and it appears as though some areas were never built up to height of dam crest which would detrimentally affect the spillway's operation.	Should be riprapped.
DISCHARGE CHANNEL	Masonry spillway channel tied into main stream channel below dam.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	---	
APPROACH CHANNEL	---	
DISCHARGE CHANNEL	---	
BRIDGE AND PIERS	---	
GATES AND OPERATION EQUIPMENT	---	

OUTLET WORKS

GATE HOUSE

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	---	
INTAKE STRUCTURE	---	
OUTLET STRUCTURE	---	
OUTLET CHANNEL	---	
EMERGENCY GATE	---	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Unobstructed, no debris to bridge. Roadway and bridge over stream about 500 feet downstream.	
SLOPES	Well sloped.	
APPROXIMATE NO. OF HOMES AND POPULATION	One house immediately below dam. Village of Hamilton two miles downstream.	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Not observed	
OBSERVATION WELLS	Two, One in the center of each embankment.	
WEIRS	Not observed	
PIEZOMETERS	Not observed.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Not well sloped.	
SEDIMENTATION	Not observed.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE 1

NAME OF DAM Lake Moraine

ID # _____

ITEM	REMARKS
AS-BUILT DRAWINGS	None. Dale Engineering performed limited surveying of dam.
REGIONAL VICINITY MAP	See this report.
CONSTRUCTION HISTORY	Constructed in 1836.
TYPICAL SECTIONS OF DAM	See this report for surveyed data by Dale Engineering
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See this report for surveyed data by Dale Engineering.
RAINFALL/RESERVOIR RECORDS	None.

ITEM	REMARKS
DESIGN REPORTS	None
GEOLOGY REPORTS	*See this report.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None
POST-CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	No data

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	No Data
HIGH POOL RECORDS	No Data
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	No Data
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	No Data
MAINTENANCE OPERATION: RECORDS	See this report and also New York State Department of Transportation.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	See this report, Surveyed by Dale Engineering
OPERATING EQUIPMENT PLANS & DETAILS	See this report and also New York State Department of Transportation.

CHECK LIST
HYDROLOGIC & HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: _____

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): _____

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): _____

ELEVATION MAXIMUM DESIGN POOL: _____

ELEVATION TOP DAM: _____

CREST:

a. Elevation _____
b. Type _____
c. Width _____
d. Length _____
e. Location Spillover _____
f. Number and Type of Gates _____

OUTLET WORKS:

a. Type _____
b. Location _____
c. Entrance Inverts _____
d. Exit Inverts _____
e. Emergency Draindown Facilities _____

HYDROMETEOROLOGICAL GATES:

a. Type _____
b. Location _____
c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: _____

APPENDIX B

PREVIOUS INSPECTION REPORTS/RELEVANT CORRESPONDENCE

BM 282a (2/76)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU
SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104057010 3
PROJECT LAKE MORAINE DAM
SOIL SERIES
COORD. LOC.
DATE START 7-3-79 DATE FINISH 7-9-79

HOLE DH #1
L
OFFSET
SURF. ELEV.
DEPTH TO WATER 26.0 7-9-79

CASING O.D. 2 7/8" I.D. 2 15/32 WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18"
SAMPLER O.D. 2" I.D. 1 1/2" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER

DEPTH BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/.5	.5/1.0	1.0/1.5	1.5/2.0	DESCRIPTION OF SOIL AND ROCK	MOIST CON %
0	27							
	55							
	63							
	28						BR. SANDY SILT W/ STONE FRAG. M.N.P.	8.2
5.0	23							
	20	1	4	4	4			
	20							
	24							
	15						BR. SANDY SILT, CLAYEY W/ ROOT FIBERS, S[illegible] FINE FRAG. W.P.	16.1
10.0	10							
	14	2	3	3	2			
	6							
	10						BR GR SANDY SILT, CLAYEY W/ GRAVEL W.P.	19.3
	12							
15.0	9							
	16	3	3	3	3			
	13							
	16							
	16						GR. BR. GRAVELLY SILT, CLAYEY W/SAND W.P.	12.3
20.0	17							
	16	4	3	2	3			
	17							
	17							
	24						GR BR. GRAVELLY SILT, CLAYEY W/S[illegible] W.P.	12.8
25.0	25							
	13	5	2	3	3			
	22							
	31							
	33						GR BR. GRAVELLY SILT, CLAYEY W/ SAND W.P.	19.1
30.0	34							
	25	6	4	2	3			
	30							
	40						GR. BR. SANDY GRAVEL, SILTY W/CLAY W.L.P.	12.3
	47							
35.0	23							
	30	7	13	11	13			
	43							
	47						GR. BR. SANDY GRAVEL, SILTY W/ CLAY W.L.P.	11.6
	72							
40.0	105							
	120	8	17	18	10			
	115							
	200						GR. BR. SANDY GRAVEL, SILTY W.N.P.	9.7
	210							
45.0	65							
	156	9	24	32	20			
	175							
	168							
	190							
50.0	166*							

THE SUBSURFACE INFORMATION SHOWN HEREON WAS OBTAINED FOR STATE DESIGN AND ESTIMATE PURPOSES. IT IS MADE AVAILABLE TO AUTHORIZED USERS ONLY THAT THEY MAY HAVE ACCESS TO THE SAME INFORMATION AVAILABLE TO THE STATE. IT IS PRESENTED IN GOOD FAITH, BUT IS NOT INTENDED AS A SUBSTITUTE FOR INVESTIGATIONS, INTERPRETATION OR JUDGMENT OF SUCH AUTHORIZED USERS.

CONTRACTOR _____ SM _____

DRILL RIG OPERATOR G. LAMANQUE
SOIL & ROCK DESCRIP. J. QUINN
REGIONAL SOILS ENGR. [illegible]
SHEET 1 OF 2
STRUCTURE NAME/NO.

HOLE DH #1

SM 202e (2/76)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104.CS 20.03
PROJECT LAKE MORAINE DAM
SOIL SERIES
COORD. LOC.
DATE START 7-3-79 DATE FINISH 7-9-79

HOLE DH 1
LINE
STA
OFFSET
SURF. ELEV.
DEPTH TO WATER 26.0 7-9-79

CASING O.D. 2 7/8 I.D. 2 15/32 WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18"
SAMPLER O.D. 2" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER [illegible]

DEPTH BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	DESCRIPTION OF SOIL AND ROCK	W CONT. %
50.0			10	10	16	22	SILTY SAND, GRAVELLY w NP	9.3
							STOPPED HOLE 51.5	
							SPOONED CASING DRY 0.0 - 2	
							WASHED CASING TO BOTTOM 20' - 50'	
							INSTALLED 1" PLASTIC PIPE [illegible] PULLED CASING	

THE SUBSURFACE INFORMATION SHOWN HEREON WAS OBTAINED FOR STATE DESIGN AND ESTIMATE PURPOSES. IT IS MADE AVAILABLE TO AUTHORIZED USERS ONLY THAT THEY MAY HAVE ACCESS TO THE SAME INFORMATION AVAILABLE TO THE STATE. IT IS PRESENTED IN GOOD FAITH, BUT IS NOT INTENDED AS A SUBSTITUTE FOR INVESTIGATIONS, INTERPRETATION OR JUDGMENT OF SUCH AUTHORIZED USERS.

CONTRACTOR ______ SM ______

DRILL RIG OPERATOR G. LAMANQUE
SOIL & ROCK DESCRIP. [illegible]
REGIONAL SOILS ENGR. [illegible]
SHEET 2 OF 2
STRUCTURE NAME/NO.

HOLE DH #1

SM 282d (2/72)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104 05 701 03
PROJECT LAKE MORRINA DAM
SOIL SERIES
COORD. LOC.
DATE START 7-9-79 DATE FINISH 7-13-79

HOLE # DH 2
STA
OFFSET
SURF. ELEV.
DEPTH TO WATER 24.5 7-10-79

CASING O.D. 2 7/8" I.D. 2 5/8" WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18" IN.
SAMPLER O.D. 2" I.D. 1 1/2" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER 18" IN.

DEPTH BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/6 6/12 12/18 18/24	DESCRIPTION OF SOIL AND ROCK	MOIST CONT. %
0	40				
	28				
	21			GR. BR. GRAVELLY SILT, SANDY ... M. NP	14.4
	21				
5.0	19				
	15	1	6 6 5		
	20				
	25				
	14			GR. GRAVELLY SILT, SANDY ... M	
10.0	16				SAND
	18	2	4 3 3		
	16				
	32				
	28			GR. SANDY SILT, CLAYEY W/GRAVEL ... W. PL	16.7
15.0	23				
	17	3	4 3 4		
	13				
	13				
	11			GR. GRAVELLY SILT, SANDY W/CLAY ... W. LP	12.9
20.0	11				
	20	4	4 5 11		
	15				
	17				
	17			GR. BR. SANDY SILT, GRAVELLY, W/CLAY ... W	7.7
25.0	38				
	11	5	3 5 5		
	14				
	20				
	3			GR. BR. CLAYEY SILT, GRAVELLY ... W. PL	15.3
30.0	20				
	20	6	6 4 5		
	28				
	22				
	28			GR. BR. GRAVELLY SILT, CLAYEY ... W	11.6
35.0	25				
	28	7	10 7 6		
	24				
	44				
	48			GR. GRAVELLY SILT, SANDY ... M. NP	8.5
40.0	60				
	36	8	7 5 7		
	28				
	41				
	35			GR. BR. GRAVELLY SAND, SILTY W/BOULDERS ... M. NP	8.5
45.0	37				
	40	9	4 4 5		
	28				
	40				
50.0	37				

THE SUBSURFACE INFORMATION SHOWN HEREON WAS OBTAINED FOR STATE DESIGN AND ESTIMATE PURPOSES. IT IS MADE AVAILABLE TO AUTHORIZED USERS ONLY THAT THEY MAY HAVE ACCESS TO THE SAME INFORMATION AVAILABLE TO THE STATE. IT IS PRESENTED IN GOOD FAITH, BUT IS NOT INTENDED AS A SUBSTITUTE FOR INVESTIGATIONS, INTERPRETATION OR JUDGMENT OF SUCH AUTHORIZED USERS.

CONTRACT _____ SM _____

DRILL RIG OPERATOR G. LAMANCE
SOIL & ROCK DESCRIP. J. [illegible]
REGIONAL SOILS ENGR. [illegible]
SHEET 1 OF 2
STRUCTURE NAME/NO. _____

HOLE DH 2

SM 282d (2/72)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104 CS 70103
PROJECT LAKE MORAINE DAM
SOIL SERIES
COORD. LOC.
DATE START 7-9-79 DATE FINISH 7-13-79

HOLE DH #2
LINE
STA
OFFS
SURF. ELEV.
DEPTH TO WATER 39.5' 7-11-79

CASING O.D. 2½" I.D. 2 15/32 WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18" IN.
SAMPLER O.D. 1⅜" I.D. 1⅛" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER 18" IN.

DEPTH BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/6 6/12 12/18 18/24	DESCRIPTION OF SOIL AND ROCK
50.0				
	10	6	7 6	FR BR GRAVELLY SAND, SILTY W/ COBBLES & BOULDERS 13.5
				ENDED HOLE 51.5'
				SPOONED OUT CASING DRY C.O. – 25.0'
				WASHED CASING 2½" – 51.0
				INSTALLED 1" PLASTIC PIPE TO BOTTOM OF HOLE
				PULLED CASING

THE SUBSURFACE INFORMATION SHOWN HEREON WAS OBTAINED FOR STATE DESIGN AND ESTIMATE PURPOSES. IT IS MADE AVAILABLE TO AUTHORIZED USERS ONLY THAT THEY MAY HAVE ACCESS TO THE SAME INFORMATION AVAILABLE TO THE STATE. IT IS PRESENTED IN GOOD FAITH, BUT IS NOT INTENDED AS A SUBSTITUTE FOR INVESTIGATIONS, INTERPRETATION OR JUDGMENT OF SUCH AUTHORIZED USERS.

CONTRACTOR _____ SM _____

DRILL RIG OPERATOR G. LAMANQUE
SOIL & ROCK DESCRIP. J. QUINN
REGIONAL SOILS ENGR. [illegible]
SHEET 2 OF 2
STRUCTURE NAME/NO.

HOLE DH #2

M 282d (2/72)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104 05 701 03
PROJECT LAKE MORAINE DAM
SOIL SERIES
COORD. LOC.
DATE START 7-9-79 DATE FINISH 7-13-79

HOLE DH #2
LINE
STA
OFFSET
SURF. ELEV.
DEPTH TO WATER 24.5 7-16-79

CASING O.D. 2 7/8" I.D. 2 1/2" WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18" IN.
SAMPLER O.D. 2" I.D. 1 1/2" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER 18" IN.

BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	DESCRIPTION OF SOIL AND ROCK		VOIDS CONT. %
40								
28								
21						GR. BR. GRAVELLY SILT, SANDY	M NP	14.4
21								
19								
15	1	6	6	5				
20								
25								
14						GR. GRAVELLY SILT, SANDY	M (NP)	SAND
18								
18	2	4	2	3				
16								
32								
28								
23						GR. SANDY SILT, CLAYEY W/ GRAVEL	W. PL	16.5
17	3	4	3	4				
13								
13								
11						GR. GRAVELLY SILT, SANDY W/ CLAY	W. LP	12.9
11								
20	4	4	5	11				
17								
17								
38						GR. BR. SANDY SILT, GRAVELLY, W/CLAY	W	7.7
11	5	3	5	5				
16								
20								
13						GR. BR. CLAYEY SILT, GRAVELLY	W PL	15.3
20								
20	6	6	4	5				
20								
22								
28						GR. BR. GRAVELLY SILT, CLAYEY	W PL	11.0
35								
38	7	10	7	6				
34								
44								
48						GR. GRAVELLY SILT, SANDY	M (NP)	8.5
60								
36	8	7	5	7				
28								
41								
35								
37						GR. BR. GRAVELLY SAND, SILTY W/DECAYED WOOD	NP	16.5
40	9	4	4	5				
32								
40								
37								
37								

THE SUBSURFACE INFORMATION SHOWN HEREON WAS OBTAINED FOR STATE DESIGN AND ESTIMATE PURPOSES. IT IS MADE AVAILABLE TO AUTHORIZED USERS ONLY THAT THEY MAY HAVE ACCESS TO THE SAME INFORMATION AVAILABLE TO THE STATE. IT IS PRESENTED IN GOOD FAITH, BUT IS NOT INTENDED AS A SUBSTITUTE FOR INVESTIGATIONS, INTERPRETATION OR JUDGMENT OF SUCH AUTHORIZED USERS.

CONTRACTOR _____ SM _____

DRILL RIG OPERATOR G. LAMANCE
SOIL & ROCK DESCRIP. J. QUINN
REGIONAL SOILS ENGR. Richard A. Cook
SHEET 1 OF 2
STRUCTURE NAME/NO.

HOLE DH 2

M 282d (2/72)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU
SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104 05 701 03
PROJECT LAKE MORAINE DAM
SOIL SERIES
COORD. LOC.
DATE START 7-9-79 DATE FINISH 7-13-79

HOLE DH #2
LINE
STA
OFFS
SURF. ELEV.
DEPTH TO WATER 34.5 7-11-79

CASING O.D. 2.7[illegible] I.D. 2 15/32 WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18" IN.
SAMPLER O.D. [illegible] I.D. 1 1/2 WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER 18" IN.

ELEVATION BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/6	6/12	12/18	18/24	DESCRIPTION OF SOIL AND ROCK	STRATUM CHANGE
0.0								
			10	6	7	6	FR BR GRAVELLY SAND, SILTY w/ [illegible]	13.0
							END OF HOLE 51.5'	
							SPOONED OUT CASING DRY 0.0 – 25.0	
							WASHED CASING [illegible]	
							INSTALLED 1" PLASTIC PIPE TO [illegible]	
							PULLED CASING	

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CONTRACTOR _____ SM _____

DRILL RIG OPERATOR G. LAMANQUE
SOIL & ROCK DESCRIP. J. QUINN
REGIONAL SOILS ENGR. [illegible]
SHEET 2 OF 2
STRUCTURE NAME/NO.

HOLE DH #2

4 283e (2/76)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU
SUBSURFACE EXPLORATION LOG

EGION 2
OUNTY MADISON
IN E104 05 701 03
ROJECT LAKE MORAINE DAM
OIL SERIES
OORD. LOC.
ATE START 7-3-79 DATE FINISH 7-9-79

HOLE DH #1
LINE
STA.
OFFSET
SURF. ELEV.
DEPTH TO WATER 26.0 7-9-79

ASING O.D. 2 7/8" I.D. 2 5/8" WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18"
AMPLER O.D. 2" I.D. 1 1/2" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER 18"

BELOW SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS ON SAMPLER 0/.5	.5/1.0	1.0/1.5	1.5/2.0	DESCRIPTION OF SOIL AND ROCK	MOIST. CONT. %
	27							
	55							
	63							
	28						BR. SANDY SILT W/ STONE FRAG. ... M.N.P.	8.2
5'0.0	22							
	20	1	4	4	4			
	20							
	24							
	15						BR. SANDY SILT, CLAYEY W/ ROOT FIBERS, STONE FRAG.	
10'0.0	10						W.P.	16.1
	14	2	2	3	2			
	6							
	10						BR. GR. SANDY SILT, CLAYEY W/ GRAVEL ... W.P.	
	12							19.3
15'0.0	9							
	16	3	3	3	3			
	13							
	16							
	16						GR. BR. GRAVELLY SILT, CLAYEY W/SAND ... W.P.	12.3
20'0.0	17							
	16	4	3	2	3			
	17							
	17							
	24						GR. BR. GRAVELLY SILT, CLAYEY W/SA ... M.P.	12.8
25'0.0	25							
	13	5	2	3	3			
	22							
	31							
	33						GR. BR. GRAVELLY SILT, CLAYEY W/ SAND ... W.P.	19.1
30'0.0	34							
	25	6	4	2	3			
	30							
	40							
	47						GR. BR. SANDY GRAVEL, SILTY W/CLAY ... W.L.P.	12.3
35'0.0	23							
	30	7	13	11	13			
	43							
	47						GR. BR. SANDY GRAVEL, SILTY W/ CLAY ... W.L.P.	11.6
	72							
40'0.0	105							
	120	8	17	18	10			
	115							
	200						GR. BR. SANDY GRAVEL, SILTY ... W.N.P.	9.4
	210							
45'0.0	65							
	156	9	24	32	20			
	195							
	168							
50'0.0	190							
	164+							

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CONTRACTOR _____ SM _____

DRILL RIG OPERATOR G. LAMANQUE
SOIL & ROCK DESCRIP. J. QUINN
REGIONAL SOILS ENGR. Robert A. Page
SHEET 1 OF 2
STRUCTURE NAME/NO. _____

HOLE DH #1

1 283e (2/76)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
SOIL MECHANICS BUREAU

SUBSURFACE EXPLORATION LOG

REGION 2
COUNTY MADISON
PIN E104C5 70103
PROJECT LAKE MORAINE DAM
SOIL SERIES
COORD. LOC.
DATE START 7-3-79 DATE FINISH 7-9-79

HOLE DH #1
LINE
STA
OFFSET
SURF. ELEV.
DEPTH TO WATER 26.0
7-9-79

CASING O.D. 2 7/8" I.D. 2 15/16" WEIGHT OF HAMMER - CASING 300 LBS. HAMMER FALL - CASING 18"
SAMPLER O.D. 2" I.D. 1 3/8" WEIGHT OF HAMMER - SAMPLER 300 LBS. HAMMER FALL - SAMPLER 18"

ELEV. SURFACE	BLOWS ON CASING	SAMPLE NO.	BLOWS SAMPLER 0-.5 / .5-1.0 / 1.0-1.5	DESCRIPTION OF SOIL AND ROCK	MOIST. CONT. %
30	10	10	16 22	SILTY SAND, GRAVEL w NP	9.3
				STOPPED HOLE 5'-0	
				SPOONED CASING DRY 0.0 - 20.0	
				WASHED CASING TO BOTTOM 20.0 - 50.0	
				INSTALLED 1" PLASTIC PIPE 50'0	
				PULLED CASING	

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CONTRACTOR _____ SM _____

DRILL RIG OPERATOR G. LAMANQUE
SOIL & ROCK DESCRIP. J. QUINN
REGIONAL SOILS ENGR. [illegible]
SHEET 2 OF 2
STRUCTURE NAME/NO.

HOLE DH #1

APPENDIX C

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

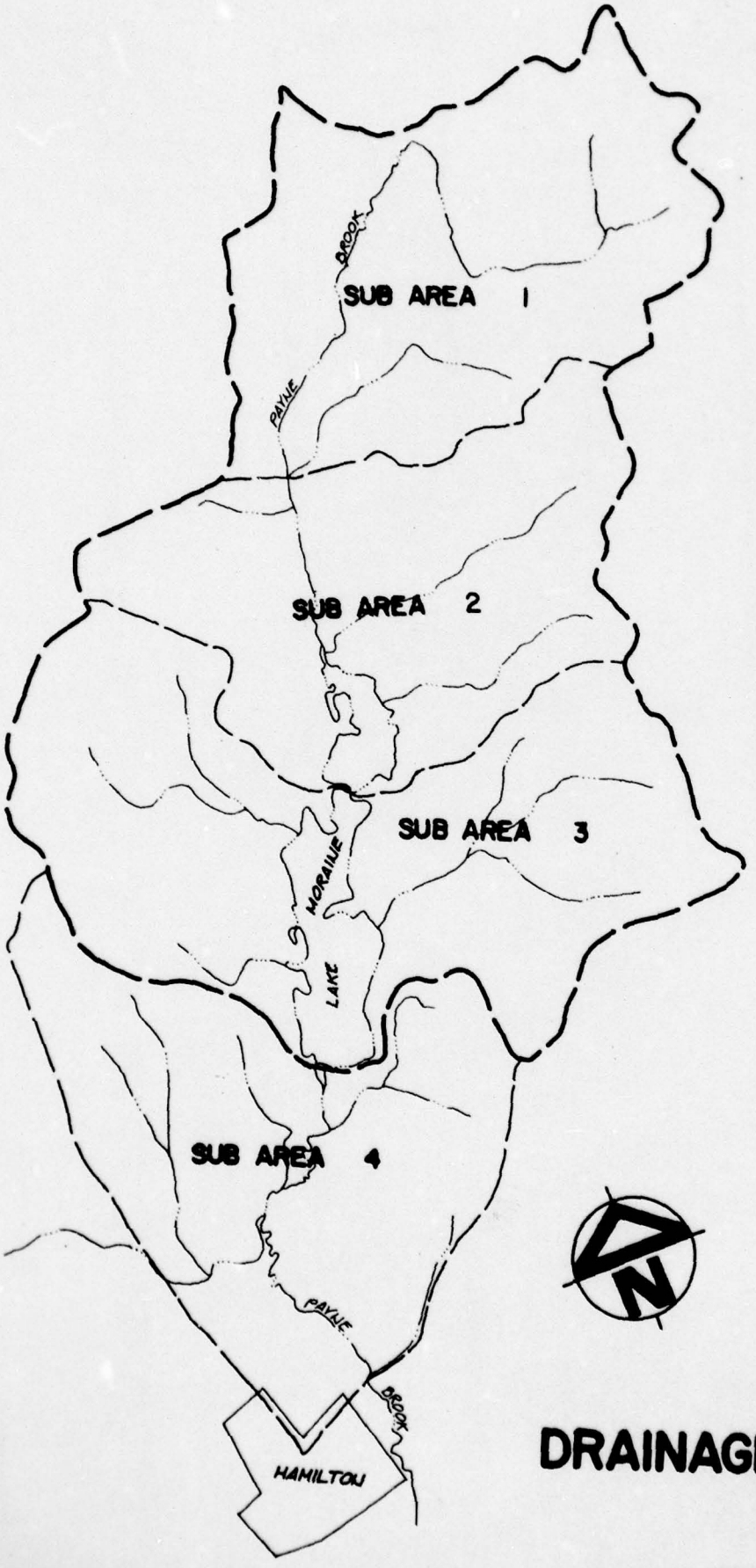
STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501 TEL 315-797-5800 **DESIGN BRIEF**

PROJECT NAME New York State Dam Inspection DATE 8-24-79

SUBJECT Lake Moraine Dam PROJECT NO. 2305

Sub Area - Area DRAWN BY JPG

		Area		
Sub Area	1	1625.3 Acres	2.54 Sq Mi	
" "	2	1510.6 Acres	2.36 Sq Mi	
" "	3	2121.2 Acres	3.31 Sq Mi	
" "	4	1605.9 Acres	2.51 Sq Mi	(Downstr Hazard)
Total D.A. of Dam		5257.1 Acres	8.21 Sq Mi	
Lake Area		252.5 Acres	.39 Sq Mi	



DRAINAGE BASIN

STETSON • DALE BANKERS TRUST BUILDING UTICA • NEW YORK • 13501 TEL 315-797-5800

DESIGN BRIEF

PROJECT NAME NEW YORK STATE DAM INSPECTION DATE 8-24-79

SUBJECT LAKE MORAINE DAM PROJECT NO. 2305

ESTIMATE OF CLARK'S PARAMETER DRAWN BY JPG

ESTIMATE OF T_c

$T_c = 11.9\ (L^3/H)^{.385}$

	L (MI)	H (FT)	T_c (HRS)	R
SUB AREA 1	3.71	475	5.04	
" " 2	2.51	489	3.18	
" " 3	2.31	489	2.88	
4	2.97	485	3.87	

SCS

$L = \frac{l^{.8}(S+1)^{.7}}{1900\ Y^{.5}}$ $\quad T_c = L/.6$ $\quad S = \frac{1000}{CN} - 10$

	l (FT)	S	Y (%)	L	T_c	R
SUB AREA 1	19600	3.89	10	1.37	2.29	
" " 2	13300	3.89	15	.82	1.37	
" " 3	12200	3.89	12	.86	1.42	
4	10000	3.89	6	1.03	1.72	

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DESIGN BRIEF

PROJECT NAME NEW YORK STATE DAM INSPECTION DATE 9.24.79

SUBJECT LAKE MORAINE DAM PROJECT NO. 2305

ESTIMATE OF SNYDER'S PARAMETER DRAWN BY JPG

640 C_P

.77 FOR ALL SUB AREAS

$t_p = C_t (L \times L_{CA})^{.3}$

	C_t	L (MI)	L_{CA} (MI)	t_p
SUB AREA 1	2.0	3.71	2.20	3.77
" 2	2.0	2.51	1.55	3.00
" 3	2.0	2.31	1.50	2.90
" 4	3.0	1.89	1.00	3.63

$t_r = t_p / 5.5$

	t_p	t_r
SUB AREA 1	3.77	.68
" " 2	3.00	.55
" " 3	2.90	.53
" " 4	3.63	.66

$t_{pr} = t_p + .25 (t_R - t_r)$

	t_p	t_R	t_r	t_{pr}
SUB AREA 1	3.77	1.0	.68	3.85
" " 2	3.00	1.0	.55	3.11
" " 3	2.90	1.0	.53	3.02
" " 4	3.63	1.0	.66	3.72

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TEL 315-797-5800

DESIGN BRIEF

PROJECT NAME: NEW YORK STATE DAM INSPECTION — DATE: 8.24.79

SUBJECT: LAKE MORAINE DAM — PROJECT NO. 2305

DEPTH-AREA-DURATION — DRAWN BY: JPG

PMF - INDEX RAINFALL = 19.5"; 200 SQ MI; 24 HRS

DURATION	DEPTH	% INDEX
6 HR	21.6	111
12 HR	24.0	123
24 HR	26.0	133
48 HR	27.7	142

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DESIGN BRIEF

PROJECT NAME NEW YORK STATE DAM INSPECTION DATE 9-24-79

SUBJECT LAKE MORAINE DAM PROJECT NO. 2305

STAGE - STORAGE DRAWN BY JPG

$$V_{LAKE} = h/3 \ (A_1 + A_2 + \sqrt{A_1 A_2})$$

$$= 20/3 \ (252.5 + .1 + \sqrt{252.5 \times .1})$$
$$= 20/3 \ (252.5 + .1 + 5.0)$$
$$= 1717.4 \text{ ACRE-FT}$$

ELEV	STORAGE
1211	1717.4
1212	1969.9
1213	2222.4
1214	2474.9
1215	2727.4
1216	2979.9
1217	3232.4
1218	3484.9
1219	3737.4
1220	3989.9

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DESIGN BRIEF

PROJECT NAME _____ DATE 9-10-79

SUBJECT Lake Moraine PROJECT NO. _____

DRAWN BY JAG

Spillway Capacity

Length, L = 35'

Crest Elev. = 1211.0

Assumed discharge coefficient C = 3.2

$Q = C L H^{3/2}$

Elev.	H, ft	Q, c.f.s
1211.0	0	—
1211.2	0.2	10.
1211.4	0.4	28
1211.6	0.6	52
1211.8	0.8	80
1212.0	1.0	112
1212.5	1.5	205
1213.0	2.0	317
1213.5	2.5	443
1214.0	3.0	582
1214.5	3.5	735
1215.0	4.0	895
1215.5	4.5	1070
1216.0	5.0	1250
1217.0	6.0	1650
1218.0	7.0	2075
1219.0	8.0	2535
1220.0	9.0	3025

AAUD

```
(0001)  A1      LAKE MORAINE DAM
(0002)  A2      HEC-1DB
(0003)  A3      PMF-DAM OVERTOPPING ANALYSIS (SNYDERS)
(0004)  B       90        1         0         0         0         0         0         0         4
(0005)  B1      5
(0006)  J       1         6         1
(0007)  J1      .2        .4        .5        .6        .8        1.0
(0008)  K       0         1         0         0         0         0         1
(0009)  K1      SUB AREA-1 RUNOFF
(0010)  P       1         1         2.54      0         8.21      0         0         0         1
(0011)  P       0         19.5      111       123       133       142
(0012)  T       0         0         0         0         0         0         1         0.1
(0013)  L       3.85      .77
(0014)  X       5         5         1
(0015)  K       1         2         0         0         0         0         1
(0016)  K1      CHANNEL ROUTE THRU SUB AREA-2
(0017)  Y       0         0         0         1         1
(0018)  Y1      1         0         0         0         0         0         -1
(0019)  Y6      .08       .04       .08       1211      1240      7200      .002
(0020)  Y7      100       1240      250       1220      475       1211      477       1210      490       1210
(0021)  Y7      493       1211      750       1220      1500      1240
(0022)  K       0         2         0         0         0         0         1
(0023)  K1      SUB AREA-2 RUNOFF
(0024)  K       1         1         2.38      0         8.21      0         0         0         1
(0025)  P       0         19.5      111       123       133       142
(0026)  T       0         0         0         0         0         0         1         0.1
(0027)  L       3.11      .77
(0028)  X       4         4         1
(0029)  K       2         2         0         0         0         0         1
(0030)  K1      COMBINE 2 HYDROGRAPHS AT 2
(0031)  K       1         3         0         0         0         0         1
(0032)  K1      CHANNEL ROUTE THRU SUB AREA-3
(0033)  Y       0         0         0         1         1
(0034)  Y1      1         0         0         0         0         0         -1
(0035)  Y6      .08       .04       .08       1211      1240      6100      .00001
(0036)  Y7      100       1240      300       1220      450       1211      500       1201      2100      1201
(0037)  Y7      2150      1211      2400      1220      2700      1240
(0038)  K       2         3         0         0         0         0         1
```

```
(0039)  K1      SUB AREA-3
(0040)  R       1       1    3.31       0    8.21       0       0       0       1
(0041)  P       0    19.5     111     123     133     142
(0042)  T       0       0       0       0       0       1     0.1
(0043)  W    3.02     .77
(0044)  X       6       4       1
(0045)  K       2       3       0       0       0       0       1
(0046)  K1      COMBINE 2 HYDROGRAPHS AT 3
(0047)  K       1     100       0       0       0       0       1
(0048)  K1      ROUTE OVER LAKE MORAINE DAM
(0049)  Y       0       0       0       1       1
(0050)  Y1      1       0       0       0       0       0      -1
(0051)  SS   1717    1970    2222    2475    2727    2980    3232    3485    3737    3990
(0052)  SS   4242    4495    4747    5000
(0053)  SE   1211    1212    1213    1214    1215    1216    1217    1218    1219    1220
(0054)  SE   1221    1222    1223    1224
(0055)  SS1211.0    35.0     3.2     1.5
(0056)  SD   1216     2.6     1.5    1400
(0057)  K1      1       4       0       0       0       0       1
(0058)  K1      CHANNEL ROUTE THRU SUB AREA-4
(0059)  Y       0       0       0       1       1
(0060)  Y1      1       0       0       0       0       0      -1
(0061)  Y6    .08     .04     .08    1113    1130   10000   .0001
(0062)  Y7    100    1126    2200    1120    2230    1115    2240    1113    2250    1113
(0063)  Y7   2260    1115    2500    1120    2900    1130
(0064)  K       0       4       0       0       0       0       1
(0065)  K1      SUB AREA-4 RUNOFF
(0066)  R       1       1    2.51       0    8.21       0       0       0       1
(0067)  P       0    19.5     111     123     133     142
(0068)  T       0       0       0       0       0       1     0.1
(0069)  W    3.72     .77
(0070)  X       5       5       1
(0071)  K       2       4       0       0       0       0       1
(0072)  K1      COMBINE 2 HYDROGRAPHS AT 4
(0073)  K      99
(0074)  A
(0075)  A
(0076)  A
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE?WED, SEP 12 1979
     TIME?13:37:14

                    LAKE MORAINE DAM
                    HEC-1DB
                    FPF=DAM OVERTOPPING ANALYSIS (SNYDERS)

                                  JOB SPECIFICATION
        NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
        90        1        0        0        0        0        0        0        4        0
                                  JOPER      NWT    LROPT    TRACE
                                      5        0        0        0

                              MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN= 1 NRTIO= 6 LRTIO= 1
                RTIOS=    0.20    0.40    0.50    0.60    0.80    1.00

**********      **********      **********      **********      **********

                              SUB-AREA RUNOFF COMPUTATION

                SUB AREA-1 RUNOFF
                          ISTAQ   ICOMP    IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                              1       0        0        0        0        0        1        0        0

                                      HYDROGRAPH DATA
            IHYDG    IUHG    TAREA    SNAP    TRSDA    TRSPC    RATIO   ISNOW   ISAME   LOCAL
                1       1     2.54    0.00     8.21     0.00    0.000       0       1       0

                                      PRECIP DATA
                        SPFE      PMS       R6      R12      R24      R48      R72      R96
                        0.00    19.50   111.00   123.00   133.00   142.00     0.00     0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.800

                                      LOSS DATA
        LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
            0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                  UNIT HYDROGRAPH DATA
                            TP=  3.85    CP=0.77    NTA=  0

                                  RECESSION DATA
                        STRTQ=    5.00    QRCSN=    5.00    RTIOR= 1.00
```

UNIT HYDROGRAPH 14 END-OF-PERIOD ORDINATES, LAG= 3.83 HOURS, CP= 0.76 VOL= 1.00

41. 142. 254. 321. 308. 225. 137. 83. 50. 31.
19. 11. 7. 4.

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	30602.
										(563.)(469.)(93.)(866.55)			

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HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SLB AREA-2

ISTAQ	ICOPT	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

GN(1)	GN(2)	GN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0800	0.0400	0.0800	1211.0	1240.0	7200.	0.002CC

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

100.00 1240.00 250.00 1220.00 475.00 1211.00 477.00 1210.00 490.00 1210.00
493.00 1211.00 750.00 1220.00 1500.00 1240.00

STORAGE	0.00	17.41	52.88	108.96	185.66	282.98	400.90	537.46	691.35
	1051.10	1256.97	1480.15	1720.66	1978.49	2253.64	2546.12	2855.92	3183.05
OUTFLOW	0.00	169.37	562.49	1308.86	2498.85	4213.96	6538.82	9618.05	13421.72
	23370.42	29602.33	36730.64	44798.49	53848.38	63922.29	75061.61	87307.05	100698.77
STAGE	1211.00	1212.53	1214.05	1215.58	1217.10	1218.63	1220.16	1221.68	1223.21
	1226.26	1227.79	1229.31	1230.84	1232.37	1233.89	1235.42	1236.94	1238.47
FLOW	0.00	169.37	562.49	1308.86	2498.85	4213.96	6538.82	9618.05	13421.72
	23370.42	29602.33	36730.64	44798.49	53848.38	63922.29	75061.61	87307.05	100698.77

MAXIMUM STAGE IS 1214.6

MAXIMUM STAGE IS 1216.7

MAXIMUM STAGE IS 1216.6

MAXIMUM STAGE IS 1217.1

MAXIMUM STAGE IS 1217.9

MAXIMUM STAGE IS 1218.7

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SUB-AREA RUNOFF COMPUTATION

SUB AREA-2 RUNOFF

ISTAQ	ICCPF	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.36	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.11 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 4.00 QRCSN= 4.00 RTIOR= 1.00

UNIT HYDROGRAPH 11 END-OF-PERIOD ORDINATES, LAG= 3.09 HOURS, CP= 0.77 VOL= 1.00

59. 198. 328. 364. 274. 149. 75. 38. 19. 10.
5.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
		SUM	22.15	18.48	3.67	28396.
			(563.)	(469.)	(93.)	(804.08)

....

COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	2	0	0	0	0	1	C	0

HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SUB AREA-5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
C.C	0.000	0.CC	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	C.000	C.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

GN(1)	GN(2)	GN(3)	ELMVT	ELMAX	RLNTH	SEL
0.0800	0.0400	0.0800	1211.0	1240.C	6100.	0.00001

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

100.00 1240.00 300.00 1220.00 450.00 1211.00 500.00 1201.00 2100.00 1201.00
2150.00 1211.00 2400.00 1220.00 2700.00 1240.00

STORAGE	0.00	2681.17	3066.22	3465.77	3879.82	4308.36	4751.37	5205.08	5666.95
	6615.14	7101.47	7595.95	8098.58	8609.37	9128.31	9655.41	10190.66	10734.06
OUTFLOW	0.00	11274.49	13954.62	16874.33	20031.01	23422.52	27048.66	30917.30	35011.11
	43861.44	48612.81	53578.86	58757.85	64148.32	69748.98	75558.72	81576.45	87801.41
STAGE	1211.00	1212.53	1214.05	1215.58	1217.10	1218.63	1220.16	1221.68	1223.21
	1226.26	1227.79	1229.31	1230.84	1232.37	1233.89	1235.42	1236.94	1238.47
FLOW	0.00	11274.49	13954.62	16874.33	20031.01	23422.52	27048.66	30917.30	35011.11
	43861.44	48612.81	53578.86	58757.85	64148.32	69748.98	75558.72	81576.45	87801.41

MAXIMUM STAGE IS 1211.2

MAXIMUM STAGE IS 1211.3

MAXIMUM STAGE IS 1211.4

MAXIMUM STAGE IS 1211.5

MAXIMUM STAGE IS 1211.7

MAXIMUM STAGE IS 1211.9

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SUB-AREA RUNOFF COMPUTATION

SUB AREA-3

ISTAQ	ICOPT	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.31	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.02 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 6.00 QRCSN= 6.00 RTIOR= 1.00

UNIT HYDROGRAPH 10 END-OF-PERIOD ORDINATES, LAG= 3.00 HOURS, CP= 0.77 VOL= 1.00

91. 302. 489. 525. 372. 186. 89. 42. 20. 10.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	39830.
										(563.)	(469.)	(93.)	(1127.86)

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COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 3

ISTAQ	ICOPP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	2	0	0	0	0	1	0	0

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HYDROGRAPH ROUTING

ROUTE OVER LAKE ROBBINS DAM

ISTAQ	ICOPP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
100	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

CAPACITY=	1717.	1970.	2222.	2475.	2727.	2980.	3232.	3485.	3737.	3990.
	4242.	4495.	4747.	5000.						
ELEVATION=	1211.	1212.	1213.	1214.	1215.	1216.	1217.	1218.	1219.	1220.
	1221.	1222.	1223.	1224.						

CREL	SPWID	COGW	EXPW	ELEVL	COGL	CAREA	EXPL
1211.0	35.0	3.2	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COGD	EXPD	DAMWID
1216.0	2.6	1.5	1400.

PEAK OUTFLOW IS 861. AT TIME 49.00 HOURS

PEAK OUTFLOW IS 3613. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5189. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 6679. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9090. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 11361. AT TIME 44.00 HOURS

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HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SUB AREA-4

ISTAQ	ICOPP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QA(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0800	0.0400	0.0800	1113.0	1130.0	10000.	0.00010

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
100.00 1126.00 2200.00 1120.00 2230.00 1115.00 2240.00 1113.00 2250.00 1113.00
2260.00 1115.00 2500.00 1120.00 2900.00 1130.00

STORAGE	0.00	2.97	7.78	16.79	35.49	64.11	102.65	151.11	210.43
	501.96	755.18	1080.05	1476.56	1944.71	2477.49	3026.73	3583.33	4147.27
OUTFLOW	0.00	3.72	14.26	36.81	76.44	138.15	226.71	346.41	489.73
	1034.29	1520.74	2196.50	3093.00	4239.36	5780.32	7737.05	9960.63	12440.01
STAGE	1113.00	1113.89	1114.79	1115.68	1116.58	1117.47	1118.37	1119.26	1120.16
	1121.95	1122.84	1123.73	1124.63	1125.52	1126.42	1127.31	1128.21	1129.10
FLOW	0.00	3.72	14.26	36.81	76.44	138.15	226.71	346.41	489.73
	1034.29	1520.74	2196.50	3093.00	4239.36	5780.32	7737.05	9960.63	12440.01

MAXIMUM STAGE IS 1120.9

MAXIMUM STAGE IS 1123.1

MAXIMUM STAGE IS 1124.0

MAXIMUM STAGE IS 1124.7

MAXIMUM STAGE IS 1125.9

MAXIMUM STAGE IS 1126.8

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SUB-AREA RUNOFF COMPUTATION

SUB AREA-4 RUNOFF

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.51	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

[illegible] COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	[illegible]	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	[illegible]	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.72 CP=0.77 NTA= [illegible]

RECESSION DATA

STRTQ= 5.00 QRCSN= 5.00 RTIOR= 1.00

UNIT HYDROGRAPH 14 END-OF-PERIOD ORDINATES, LAG= 3.69 HOURS, CP= 0.76 VOL= 1.00

43.	149.	265.	328.	299.	210.	127.	77.	47.	29.
17.	11.	6.	4.						

C

END-OF-PERICD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	30254.
										(563.)(	469.)(	93.)(	856.70)

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COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.20	RATIO 2 0.40	RATIO 3 0.50	RATIO 4 0.60	RATIO 5 0.80	RATIO 6 1.00
HYDROGRAPH AT	1	2.54	1	883.	1765.	2206.	2648.	3530.	4413.
		(6.58)		(24.99)(	49.98)(	62.47)(	74.97)(	99.96)(	124.95)(
ROUTED TO	2	2.54	1	831.	1686.	2111.	2538.	3408.	4264.
		(6.58)		(23.53)(	47.73)(	59.79)(	71.86)(	96.49)(	120.75)(
HYDROGRAPH AT	2	2.36	1	920.	1840.	2300.	2760.	3680.	4600.
		(6.11)		(26.05)(	52.10)(	65.13)(	78.15)(	104.20)(	130.25)(
2 COMBINED	2	4.90	1	1676.	3390.	4257.	5114.	6874.	8602.
		(12.69)		(47.45)(	95.99)(	120.54)(	144.82)(	194.66)(	243.59)(
ROUTED TO	3	4.90	1	1240.	2502.	3137.	3771.	5050.	6326.
		(12.69)		(35.10)(	70.85)(	88.83)(	106.79)(	143.00)(	179.14)(
HYDROGRAPH AT	3	3.31	1	1310.	2621.	3276.	3931.	5241.	6552.
		(8.57)		(37.10)(	74.21)(	92.76)(	111.31)(	148.42)(	185.52)(
2 COMBINED	3	8.21	1	2260.	4547.	5697.	6847.	9154.	11467.
		(21.26)		(64.00)(	128.76)(	161.32)(	193.89)(	259.20)(	324.70)(
ROUTED TO	100	8.21	1	861.	3613.	5189.	6679.	9090.	11361.
		(21.26)		(24.38)(	102.32)(	146.93)(	189.11)(	257.40)(	321.70)(
ROUTED TO	4	8.21	1	668.	1753.	2487.	3222.	4843.	6610.
		(21.26)		(18.93)(	49.63)(	70.41)(	91.23)(	137.13)(	187.19)(
HYDROGRAPH AT	4	2.51	1	885.	1770.	2212.	2655.	3539.	4424.
		(6.50)		(25.06)(	50.11)(	62.64)(	75.17)(	100.22)(	125.28)(
2 COMBINED	4	10.72	1	973.	2084.	3045.	4045.	6136.	8402.
		(27.76)		(27.57)(	59.01)(	86.24)(	114.54)(	173.74)(	237.93)(

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	831.	1214.6	44.00
0.40	1686.	1216.1	44.00
0.50	2111.	1216.6	44.00

0.60	2558.	1217.1	44.00
0.80	3408.	1217.9	44.00
1.00	4264.	1218.7	44.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	1240.	1211.2	45.00
0.40	2502.	1211.3	45.00
0.50	3137.	1211.4	45.00
0.60	3771.	1211.5	45.00
0.80	5050.	1211.7	45.00
1.00	6326.	1211.9	45.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1211.00	1211.00	1216.00
STORAGE	1717.	1717.	2980.
OUTFLOW	0.	0.	1252.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	1216.90	0.00	2701.	861.	0.00	49.00	0.00
0.40	1216.69	0.69	3154.	3613.	8.00	45.00	0.00
0.50	1216.98	0.98	3228.	5189.	10.00	45.00	0.00
0.60	1217.23	1.23	3289.	6679.	10.00	44.00	0.00
0.80	1217.58	1.58	3378.	9090.	12.00	44.00	0.00
1.00	1217.87	1.87	3453.	11361.	13.00	44.00	0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	668.	1120.9	54.00
0.40	1753.	1123.1	50.00
0.50	2487.	1124.0	49.00
0.60	3222.	1124.7	48.00
0.80	4843.	1125.9	48.00
1.00	6610.	1126.8	47.00

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE?THU, SEP 13 1979
     TIME?09:05:47

                    LAKE MORAINE DAM
                    HEC-1DB
                    PMF-W/LOW LEVEL OUTLET

                                 JOB SPECIFICATION
         NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IFLT    IPRT   NSTAN
         90       1       0       0       0       0       0       0       4       0
                               JOPER     NWT   LROPT   TRACE
                                   5       0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 1 NRTIO= 6 LRTIO= 1
          RTIOS=   0.20    0.40    0.50    0.60    0.80    1.00


     **********         **********         **********         **********         **********

                              SUB-AREA RUNOFF COMPUTATION

          SUB AREA-1 RUNOFF
                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                        1       0       0       0       0       0       1       0       0

                                  HYDROGRAPH DATA
         IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
             1      1    2.54    0.00    8.21    0.00   0.000       0       1       0

                                    PRECIP DATA
                     SPFE     PMS      R6     R12     R24     R48     R72     R96
                     0.00   19.50  111.00  123.00  133.00  142.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.800

                                     LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                  UNIT HYDROGRAPH DATA
                           TP=  3.85      CP=0.77      NTA=  0

                                    RECESSION DATA
```

```
                 STRTQ=    5.00    QRCSN=    5.00    RTIOR= 1.00

       UNIT HYDROGRAPH 14 END-OF-PERIOD ORDINATES, LAG=   3.83 HOURS, CP= 0.76  VOL= 1.00
     41.      162.      254.      321.      308.      225.      137.       83.       50.       31.
     19.       11.        7.        4.

   0                                  END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                          SUM  22.15  18.48   3.67   30602.
                                                                             ( 563.)( 469.)(  93.)( 866.55)

        **********         **********         **********         **********         **********

                                         HYDROGRAPH ROUTING

                CHANNEL ROUTE THRU SUB AREA-2
                          ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE  IAUTO
                              2       1       0       0      0       0      1       0      0
                                               ROUTING DATA
                QLOSS   CLOSS     AVG    IRES   ISAME   IOPT    IPMP           LSTR
                  0.0   0.000    0.00       1       1      0       0              0

                          NSTPS   NSTDL     LAG   AMSKK      X     TSK    STORA  ISPRAT
                              1       0       0   0.000  0.000   0.000     -1.      0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

    QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH    SEL
   0.0800  0.0400  0.0800  1211.0  1240.0   7200. 0.00200

    CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
     100.00 1240.00  250.00 1220.00  475.00 1211.00  477.00 1210.00  490.00 1210.00
     493.00 1211.00  750.00 1220.00 1500.00 1240.00

  STORAGE       0.00      17.41      52.88     108.96     185.66     282.98     400.90     537.46     691.35
             1051.10    1256.97    1480.15    1720.66    1978.49    2253.64    2546.12    2855.92    3183.05

  OUTFLOW       0.00     169.37     562.49    1308.86    2498.85    4213.96    6538.82    9618.05   13421.72
            23370.42   29602.33   36730.64   44798.49   53848.38   63922.29   75061.61   87307.05  100698.77

    STAGE    1211.00    1212.53    1214.05    1215.58    1217.10    1218.63    1220.16    1221.68    1223.21
             1224.26    1227.79    1229.31    1230.84    1232.37    1233.89    1235.42    1236.94    1238.47

     FLOW       0.00     169.37     562.49    1308.86    2498.85    4213.96    6538.82    9618.05   13421.72
            23370.42   29602.33   36730.64   44798.49   53848.38   63922.29   75061.61   87307.05  100698.77

MAXIMUM STAGE IS    1214.4
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MAXIMUM STAGE IS 1216.1

MAXIMUM STAGE IS 1216.6

MAXIMUM STAGE IS 1217.1

MAXIMUM STAGE IS 1217.9

MAXIMUM STAGE IS 1218.7

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SUB-AREA RUNOFF COMPUTATION

SUB AREA-2 RUNOFF

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.36	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.000

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.11 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 4.00 QRCSN= 4.00 RTIOR= 1.00

UNIT HYDROGRAPH 11 END-OF-PERIOD ORDINATES, LAG= 3.09 HOURS, CP= 0.77 VOL= 1.00

59. 198. 328. 364. 274. 149. 75. 38. 19. 10.
5.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	28396.
										(563.)	(469.)	(93.)	(804.08)

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COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	2	0	0	0	0	1	0	0

HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SUB AREA-3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0800	0.0400	0.0800	1211.0	1240.0	6100.	0.00001

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
100.00 1240.00 300.00 1220.00 450.00 1211.00 500.00 1201.00 2100.00 1201.00
2150.00 1211.00 2400.00 1220.00 2700.00 1240.00

STORAGE	0.00	2681.17	3066.22	3465.77	3879.82	4308.36	4751.37	5205.08	5666.95
	6615.14	7101.47	7595.95	8098.58	8609.37	9128.31	9655.41	10190.66	10734.06
OUTFLOW	0.00	11274.49	13954.62	16874.33	20031.01	23422.52	27048.66	30917.30	35011.11
	43861.44	48612.81	53578.86	58757.85	64148.32	69748.98	75558.72	81576.45	87801.41
STAGE	1211.00	1212.53	1214.05	1215.58	1217.10	1218.63	1220.16	1221.68	1223.21
	1224.26	1227.79	1229.31	1230.84	1232.37	1233.89	1235.42	1236.94	1238.47
FLOW	0.00	11274.49	13954.62	16874.33	20031.01	23422.52	27048.66	30917.30	35011.11
	43861.44	48612.81	53578.86	58757.85	64148.32	69748.98	75558.72	81576.45	87801.41

MAXIMUM STAGE IS 1211.2

MAXIMUM STAGE IS 1211.3

MAXIMUM STAGE IS 1211.4

MAXIMUM STAGE IS 1211.5

MAXIMUM STAGE IS 1211.7

MAXIMUM STAGE IS 1211.9

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SUB-AREA RUNOFF COMPUTATION

SUB AREA-3

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.31	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LOSS	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSPX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.02 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 10 END-OF-PERIOD ORDINATES, LAG= 3.00 HOURS, CP= 0.77 VOL= 1.00

71.	302.	489.	563.	572.	486.	289.	142.	60.	10.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	39830.
										(563.)	(469.)	(93.)	(1127.86)

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COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	2	0	0	0	0	1	0	0

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HYDROGRAPH ROUTING

ROUTE OVER LAKE MORAINE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
100	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVG	IRES	ISAME	ICPT	IPPP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

CAPACITY=	0.	1717.	1970.	2222.	2475.	2727.	2980.	3232.	3485.	3737.
	3990.	4242.	4495.	4747.	5000.					
ELEVATION=	1187.	1211.	1212.	1213.	1214.	1215.	1216.	1217.	1218.	1219.
	1220.	1221.	1222.	1223.	1224.					

CREL	SPWID	COGW	EXPW	ELEVL	COGL	CAREA	EXPL
1211.0	35.0	3.2	1.5	1187.2	0.8	1.6	0.5

DAM DATA

TOPEL	COGD	EXPD	DAMWID
1216.0	2.6	1.5	1400.

PEAK OUTFLOW IS 55. AT TIME 56.00 HOURS

PEAK OUTFLOW IS 867. AT TIME 51.00 HOURS

PEAK OUTFLOW IS 1881. AT TIME 49.00 HOURS

PEAK OUTFLOW IS 3970. AT TIME 47.00 HOURS

PEAK OUTFLOW IS 7647. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 11552. AT TIME 45.00 HOURS

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HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SLE AREA-4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

BLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IFMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

SN(1)	SN(2)	SN(3)	ELMVT	ELMAX	ELNTH	SEL
0.0800	0.0400	0.0800	1113.0	1130.0	10000.	0.00010

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

100.00 1126.00 2200.00 1120.00 2230.00 1115.00 2246.00 1113.00 2250.00 1113.00
2260.00 1115.00 2300.00 1121.00 2900.00 1130.00

STORAGE	0.00	2.97	7.78	16.79	35.49	64.11	102.65	151.11	210.43
	501.99	755.18	1080.05	1476.56	1944.71	2477.49	3026.73	3583.33	4147.27
OUTFLOW	0.00	3.72	14.26	36.81	76.44	138.15	226.71	346.41	489.73
	1034.29	1526.74	2196.50	3093.00	4239.36	5780.32	7737.05	9960.63	12440.01
STAGE	1111.00	1113.86	1114.79	1115.68	1116.58	1117.47	1118.37	1119.26	1120.16
	1121.95	1122.84	1123.73	1124.63	1125.52	1126.42	1127.31	1128.21	1129.10
FLOW	0.00	3.72	14.26	36.81	76.44	138.15	226.71	346.41	489.73
	1034.29	1526.74	2196.50	3093.00	4239.36	5780.32	7737.05	9960.63	12440.01

MAXIMUM STAGE IS 1119.1

MAXIMUM STAGE IS 1120.9

MAXIMUM STAGE IS 1122.0

MAXIMUM STAGE IS 1123.1

MAXIMUM STAGE IS 1124.0

MAXIMUM STAGE IS 1125.9

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SUB-AREA RUNOFF COMPUTATION

SUB-AREA-4 RUNOFF

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.51	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.72 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 5.00 QRCSN= 5.00 RTIOR= 1.00

UNIT HYDROGRAPH 14 END-OF-PERIOD ORDINATES, LAG= 3.69 HOURS, CP= 0.76 VOL= 1.00

43. 149. 265. 328. 299. 210. 127. 77. 47. 29.
17. 11. 6. 4.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	30254.
										(563.)	(469.)	(93.)	(856.70)

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COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS					
				RATIO 1 0.20	RATIO 2 0.40	RATIO 3 0.50	RATIO 4 0.60	RATIO 5 0.80	RATIO 6 1.00
HYDROGRAPH AT	1	2.54	1	883.	1765.	2206.	2648.	3530.	4413.
	(	6.58)	(	24.99)(	49.98)(	62.47)(	74.97)(	99.96)(	124.95)(
ROUTED TO	2	2.54	1	831.	1686.	2111.	2538.	3408.	4264.
	(	6.58)	(	23.53)(	47.73)(	59.79)(	71.86)(	96.49)(	120.75)(
HYDROGRAPH AT	2	2.36	1	920.	1840.	2300.	2760.	3680.	4600.
	(	6.11)	(	26.05)(	52.10)(	65.13)(	78.15)(	104.20)(	130.25)(
2 COMBINED	2	4.90	1	1676.	3390.	4257.	5114.	6874.	8602.
	(	12.69)	(	47.45)(	95.99)(	120.54)(	144.82)(	194.66)(	243.59)(
ROUTED TO	3	4.90	1	1240.	2502.	3137.	3771.	5050.	6326.
	(	12.69)	(	35.10)(	70.85)(	88.83)(	106.79)(	143.00)(	179.14)(
HYDROGRAPH AT	3	3.31	1	1310.	2621.	3276.	3931.	5241.	6552.
	(	8.57)	(	37.10)(	74.21)(	92.76)(	111.31)(	148.42)(	185.52)(
2 COMBINED	3	8.21	1	2260.	4547.	5697.	6847.	9154.	11467.
	(	21.26)	(	64.00)(	128.76)(	161.32)(	193.89)(	259.20)(	324.70)(
ROUTED TO	100	8.21	1	55.	867.	1881.	3978.	7649.	10552.
	(	21.26)	(	1.56)(	24.55)(	53.27)(	112.66)(	216.60)(	298.81)(
ROUTED TO	4	8.21	1	54.	660.	1087.	1749.	3271.	4944.
	(	21.26)	(	1.54)(	18.69)(	30.78)(	49.51)(	92.61)(	139.99)(
HYDROGRAPH AT	4	2.51	1	885.	1770.	2212.	2655.	3539.	4424.
	(	6.50)	(	25.06)(	50.11)(	62.64)(	75.17)(	100.22)(	125.28)(
2 COMBINED	4	10.72	1	900.	1794.	2240.	2686.	3799.	5936.
	(	27.76)	(	25.49)(	50.80)(	63.42)(	76.06)(	107.58)(	168.08)(

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	831.	1214.6	44.00
0.40	1686.	1216.1	44.00

0.50	2777.	1216.6	44.00
0.60	2538.	1217.1	44.00
0.80	3408.	1217.9	44.00
1.00	4264.	1218.7	44.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	1240.	1211.2	45.00
0.40	2502.	1211.3	45.00
0.50	3137.	1211.4	45.00
0.60	3771.	1211.5	45.00
0.80	5050.	1211.7	45.00
1.00	6326.	1211.9	45.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1187.00	1211.00	1216.00
STORAGE	0.	1717.	2980.
OUTFLOW	0.	58.	1316.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	1208.47	0.00	1536.	55.	0.00	58.00	0.00
0.40	1214.72	0.00	2657.	867.	0.00	51.00	0.00
0.50	1216.25	0.25	3044.	1881.	5.00	49.00	0.00
0.60	1216.75	0.75	3169.	3978.	7.00	47.00	0.00
0.80	1217.36	1.36	3324.	7649.	10.00	45.00	0.00
1.00	1217.76	1.76	3425.	10552.	11.00	45.00	0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	54.	1116.1	72.00
0.40	660.	1120.9	57.00
0.50	1087.	1122.0	55.00
0.60	1749.	1123.1	51.00
0.80	3271.	1124.8	50.00
1.00	4944.	1125.9	49.00

A1 LAKE MORAINE DAM PAGE 0001

AAUD

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(0001)  A1      LAKE MORAINE DAM
(0002)  A2      HEC-1DB
(0003)  A3      PMF-DAM BREAK ANALYSIS
(0004)  B    90         1         0         0         0         0         0         0         4
(0005)  B1    5
(0006)  J     4         6         1
(0007)  J1   .2        .4        .5        .6        .8       1.0
(0008)  K     0         1         0         0         0         0         1
(0009)  K1      SUB AREA-1 RUNOFF
(0010)  M     1         1      2.54         0      8.21         0         0         0         1
(0011)  P     0      19.5       111       123       133       142
(0012)  T     0         0         0         0         0         0         1       0.1
(0013)  W  3.85       .77
(0014)  X     5         5         1
(0015)  K     1         2         0         0         0         0         1
(0016)  K1      CHANNEL ROUTE THRU SUB AREA-2
(0017)  Y     0         0         0         1         1
(0018)  Y1    1         0         0         0         0         0        -1
(0019)  Y6  .08       .04       .08      1211      1240      7200      .002
(0020)  Y7  100      1240       250      1220       475      1211       477      1210       490      1210
(0021)  Y7  493      1211       750      1220      1500      1240
(0022)  K     0         2         0         0         0         0         1
(0023)  K1      SUB AREA-2 RUNOFF
(0024)  M     1         1      2.36         0      8.21         0         0         0         1
(0025)  P     0      19.5       111       123       133       142
(0026)  T     0         0         0         0         0         0         1       0.1
(0027)  W  3.11       .77
(0028)  X     4         4         1
(0029)  K     2         2         0         0         0         0         1
(0030)  K1      COMBINE 2 HYDROGRAPHS AT 2
(0031)  K     1         3         0         0         0         0         1
(0032)  K1      CHANNEL ROUTE THRU SUB AREA-3
(0033)  Y     0         0         0         1         1
(0034)  Y1    1         0         0         0         0         0        -1
(0035)  Y6  .08       .04       .08      1211      1240      6100    .00001
(0036)  Y7  100      1240       300      1220       450      1211       500      1201      2100      1201
(0037)  Y7 2150      1211      2400      1220      2700      1240
(0038)  K     0         3         0         0         0         0         1
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```
(0039)  K1      SUB AREA-3
(0040)  M       1       1    3.31       0    8.21       0       0       0       1
(0041)  P       0    19.5     111     123     133     142
(0042)  T       0       0       0       0       0       0       1     0.1
(0043)  W    3.02     .77
(0044)  X       6       6       1
(0045)  K       2       3       0       0       0       0       1
(0046)  K1      COMBINE 2 HYDROGRAPHS AT 3
(0047)  K       1     100       0       0       0       0       1
(0048)  K1      ROUTE OVER LAKE MORAINE DAM
(0049)  Y       0       0       0       1       1
(0050)  Y1      1       0       0       0       0       0      -1
(0051)  $S      0    1717    1970    2222    2475    2727    2980    3232    3485    3737
(0052)  $S   3990    4242    4495    4747    5000
(0053)  $E   1190    1211    1212    1213    1214    1215    1216    1217    1218    1219
(0054)  $E   1220    1221    1222    1223    1224
(0055)  $S1211.0    35.0     3.2     1.5
(0056)  $D   1216     2.6     1.5    1400
(0057)  $B    250       1    1190       1    1211  1217.8
(0058)  $B    500       1    1190       1    1211  1217.8
(0059)  $B    750       1    1190       1    1211  1217.8
(0060)  $B   1000       1    1190       1    1211  1217.8
(0061)  K1      1       4       0       0       0       0       1
(0062)  K1      CHANNEL ROUTE THRU SUB AREA-4
(0063)  Y       0       0       0       1       1
(0064)  Y1      1       0       0       0       0       0      -1
(0065)  Y6    .05     .04     .08    1143    1130   10000   .0001
(0066)  Y7    100    1126    2200    1120    2230    1115    2240    1113    2250    1113
(0067)  Y7   2260    1115    2500    1120    2900    1130
(0068)  K       0       4       0       0       0       0       1
(0069)  K1      SUB AREA-4 RUNOFF
(0070)  M       1       1    2.51       0    8.21       0       0       0       1
(0071)  P       0    19.5     111     123     133     142
(0072)  T       0       0       0       0       0       0       1     0.1
(0073)  W    3.72     .77
(0074)  X       5       5       1
(0075)  K       2       4       0       0       0       0       1
(0076)  K1      COMBINE 2 HYDROGRAPHS AT 4
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE?MON, SEP 17 1979
     TIME?14:46:20

                    LAKE MORAINE DAM
                    HEC-1OB
                    PMF-DAM BREAK ANALYSIS

                                JOB SPECIFICATION
          NQ      NHR     NMIN     IDAY     IHR     IMIN    METRC     IPLT     IPRT    NSTAN
          90       1        0        0       0        0       0        0        4        0
                                    JOPER     NWT    LROPT   TRACE
                                      5        0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 4 NRTIO= 6 LRTIO= 1
                RTIOS=   0.20   0.40   0.50   0.60   0.80   1.00

**********      **********      **********      **********      **********

                          SUB-AREA RUNOFF COMPUTATION

                SUB AREA-1 RUNOFF
                        ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE   IAUTO
                          1       0       0       0       0       0       1       0       0

                                HYDROGRAPH DATA
              IHYDG    IUHG    TAREA    SNAP    TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                1        1      2.54    0.00    8.21    0.00   0.000       0       1       0

                                PRECIP DATA
                        SPFE     PMS      R6      R12     R24     R48     R72     R96
                        0.00   19.50  111.00  123.00  133.00  142.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.800

                                LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
            0     0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                UNIT HYDROGRAPH DATA
                          TP=  3.85    CP=0.77    NTA=  0

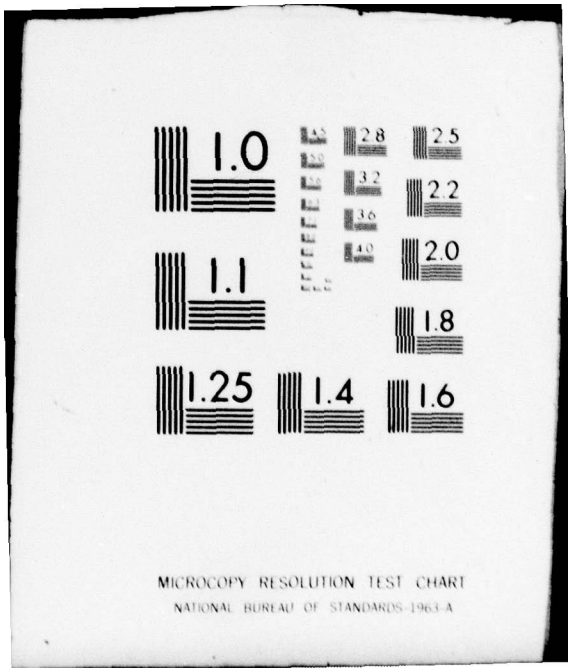
                                RECESSION DATA
                    STRTQ=    5.00    QRCSN=    5.00    RTIOR= 1.00
```

AD-A077 442 NEW YORK STATE DEPT OF ENVIRONMENTAL NSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE MOR NE DAM (INVENTORY NUMBER--ETC(U)
SEP 79 J B STETSON DACW51-79-C-0001

UNCLASSIFIED NL

2 OF 2
AD A077442

END
DATE FILMED
12-79
DDC


1.0
1.1
1.25
1.4
1.6
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
          STRTQ=     3.00     QRCSN=     3.00     RTIOR= 1.00

      UNIT HYDROGRAPH 14 END-OF-PERIOD ORDINATES, LAG=   3.83 HOURS, CP= 0.76  VOL= 1.00
       41.       142.       254.       321.       308.       225.       137.        83.        50.        31.
       19.        11.         7.         4.

      0                                      END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                         SUM  22.15  18.48   3.67   30662.
                                                                            ( 563.)( 469.)(  93.)( 866.55)

        **********         **********         **********         **********         **********

                                         HYDROGRAPH ROUTING

                     CHANNEL ROUTE THRU SUB AREA-2
                             ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                 2       1       0       0       0       0       1       0       0
                                                ALL PLANS HAVE SAME
                                                   ROUTING DATA
                     QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP                   LSTR
                       0.0   0.000    0.00       1       1       0       0                      0

                             NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                 1       0       0   0.000   0.000   0.000     -1.       0

NORMAL DEPTH CHANNEL ROUTING
----------------------------

        QN(1)   QN(2)   QN(3)   ELNVT   ELMAX   RLNTH     SEL
       0.0800  0.0400  0.0800  1211.0  1240.0   7200. 0.00200

        CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
          100.00 1240.00  250.00 1220.00  475.00 1211.00  477.00 1210.00  490.00 1210.00
          493.00 1211.00  750.00 1220.00 1500.00 1240.00

 STORAGE       0.00      17.41      52.88     108.96     185.66     282.98     400.90     537.46     691.35
            1051.11    1256.97    1480.15    1720.66    1978.49    2253.64    2546.12    2855.92    3183.05

 OUTFLOW       0.00     169.37     562.49    1308.86    2498.85    4213.96    6538.82    9418.05   13421.72
           23570.42   29602.33   36730.64   44798.49   53848.38   63922.29   75061.61   87307.05  100698.77

  STAGE     1211.00    1212.53    1214.05    1215.58    1217.10    1218.63    1220.16    1221.68    1223.21
            1226.26    1227.79    1229.31    1230.84    1232.37    1233.89    1235.42    1236.94    1238.47

   FLOW        0.00     169.37     562.49    1308.86    2498.85    4213.96    6538.82    9418.05   13421.72
           23570.42   29602.33   36730.64   44798.49   53848.38   63922.29   75061.61   87307.05  100698.77
```

```
MAXIMUM STAGE IS    1214.6
MAXIMUM STAGE IS    1216.1
MAXIMUM STAGE IS    1216.6
MAXIMUM STAGE IS    1217.1
MAXIMUM STAGE IS    1217.9
MAXIMUM STAGE IS    1218.7
MAXIMUM STAGE IS    1214.6
MAXIMUM STAGE IS    1216.1
MAXIMUM STAGE IS    1216.6
MAXIMUM STAGE IS    1217.1
MAXIMUM STAGE IS    1217.9
MAXIMUM STAGE IS    1218.7
MAXIMUM STAGE IS    1214.6
MAXIMUM STAGE IS    1216.1
MAXIMUM STAGE IS    1216.6
MAXIMUM STAGE IS    1217.1
MAXIMUM STAGE IS    1217.9
MAXIMUM STAGE IS    1218.7
MAXIMUM STAGE IS    1214.6
MAXIMUM STAGE IS    1216.1
MAXIMUM STAGE IS    1216.6
MAXIMUM STAGE IS    1217.1
MAXIMUM STAGE IS    1217.9
MAXIMUM STAGE IS    1218.7

     **********     **********     **********     **********     **********

                    [illegible] [illegible] COMPUTATION
```

SUB AREA RUNOFF COMPUTATION

SUB AREA-2 RUNOFF

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.36	0.00	8.21	0.00	C.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.11 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 4.00 QRCSN= 4.00 RTIOR= 1.00

UNIT HYDROGRAPH 11 END-OF-PERIOD ORDINATES, LAG= 3.09 HOURS, CP= 0.77 VOL= 1.00

59. 198. 328. 364. 274. 149. 75. 38. 19. 10.
5.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	28396.
										(563.)	(469.)	(93.)	(804.CE)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 2

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SUB AREA-3

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	4					1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IFMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

		GN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0800	0.0400	0.0800	1211.0	1240.0	6100.	0.00001

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
100.00 1240.00 300.00 1220.00 450.00 1211.00 500.00 1201.00 2100.00 1201.00
2150.00 1211.00 2400.00 1220.00 2700.00 1240.00

STORAGE	0.00	2621.17	3066.22	3465.77	3879.82	4308.36	4751.37	5205.08	5666.55
	6615.14	7161.47	7595.95	8098.58	8609.37	9128.31	9655.41	10190.66	10734.06
OUTFLOW	0.00	11274.49	13954.62	16874.33	20031.01	23422.52	27048.66	30917.30	35011.11
	43361.44	48012.81	53578.86	58757.85	64148.32	69748.98	75558.72	81576.45	87801.41
STAGE	1211.00	1212.53	1214.05	1215.58	1217.10	1218.63	1220.16	1221.68	1223.21
	1224.74	1227.79	1229.31	1230.84	1232.37	1233.89	1235.42	1236.94	1238.47
FLOW	0.00	11274.49	13954.62	16874.33	20031.01	23422.52	27048.66	30917.30	35011.11
	43361.44	48012.81	53578.86	58757.85	64148.32	69748.98	75558.72	81576.45	87801.41

MAXIMUM STAGE IS 1211.2

MAXIMUM STAGE IS 1211.3

MAXIMUM STAGE IS 1211.4

MAXIMUM STAGE IS 1211.5

MAXIMUM STAGE IS 1211.7

MAXIMUM STAGE IS 1211.9

MAXIMUM STAGE IS 1211.2

MAXIMUM STAGE IS 1211.3

MAXIMUM STAGE IS 1211.4

MAXIMUM STAGE IS 1211.5

MAXIMUM STAGE IS 1211.7

MAXIMUM STAGE IS 1211.9

MAXIMUM STAGE IS 1211.2

MAXIMUM STAGE IS 1211.3

MAXIMUM STAGE IS 1211.4

MAXIMUM STAGE IS 1211.5

MAXIMUM STAGE IS 1211.7

MAXIMUM STAGE IS 1211.9

MAXIMUM STAGE IS 1211.2

MAXIMUM STAGE IS 1211.3

MAXIMUM STAGE IS 1211.4

MAXIMUM STAGE IS 1211.5

MAXIMUM STAGE IS 1211.7

MAXIMUM STAGE IS 1211.9

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUB AREA-3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.31	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 3.02 CP=0.77 NTA= 0

RECESSION DATA
STRTQ= 6.CC QRCSN= 6.00 RTIOR= 1.00

UNIT HYDROGRAPH 16 END-OF-PERIOD ORDINATES, LAG= 3.0C HOURS, CP= 0.77 VOL= 1.CC
91. 302. 489. 525. 372. 186. 89. 42. 20. 1C.

O MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	39830.
										(563.)	(469.)	(93.)	(1127.86)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 3

ISTAQ	ICOPP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE OVER LAKE MORAINE DAM

ISTAQ	ICOPP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1CO	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPPP	LSTR
0.0	0.CCC	0.CC	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.CCC	C.CCC	C.CCC	-1.	0

CAPACITY=	0.	171/.	1y7C.	2222.	2475.	2727.	2980.	3232.	3485.	3737.
	3990.	4242.	4495.	4747.	5000.					
ELEVATION=	1190.	1211.	1212.	1213.	1214.	1215.	1216.	1217.	1218.	1219.
	1220.	1221.	1222.	1223.	1224.					

CREL	SPWID	COOH	EXPW	ELEVL	COOL	CAREA	EXPL
1211.0	35.0	3.2	1.5	0.C	C.C	0.0	0.0

DAM DATA

TOPEL	COED	EXPD	DAMBID
1216.0	2.6	1.5	14CC.

DAM BREACH DATA

BRBID	Z	ELBM	TFAIL	WSEL	FAILEL
25C.	1.00	1190.00	1.00	1211.00	1217.80

PEAK OUTFLOW IS 861. AT TIME 49.00 HOURS

PEAK OUTFLOW IS 3613. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5189. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 6679. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9C90. AT TIME 44.00 HOURS

BEGIN DAM FAILURE AT 43.0C HOURS

PEAK OUTFLOW IS 60068. AT TIME 43.88 HOURS

DAM BREACH DATA

BRBID	Z	ELBM	TFAIL	WSEL	FAILEL
5CC.	1.00	1190.00	1.00	1211.00	1217.80

PEAK OUTFLOW IS 861. AT TIME 49.00 HOURS

PEAK OUTFLOW IS 3613. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5189. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 6679. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9C90. AT TIME 44.00 HOURS

BEGIN DAM FAILURE AT 43.0C HOURS

PEAK OUTFLOW IS 62484. AT TIME 43.66 HOURS

DAM BREACH DATA

BRBID	Z	ELBM	TFAIL	WSEL	FAILEL
75C.	1.00	1190.00	1.00	1211.00	1217.80

PEAK OUTFLOW IS 861. AT TIME 49.00 HOURS

PEAK OUTFLOW IS 3613. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5189. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 6679. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9090. AT TIME 44.00 HOURS

BEGIN DAM FAILURE AT 43.00 HOURS

PEAK OUTFLOW IS 73592. AT TIME 43.58 HOURS

DAM BREACH DATA

BRBID	Z	ELBM	TFAIL	WSEL	FAILEL
1000.	1.00	1190.00	1.00	1211.00	1217.80

PEAK OUTFLOW IS 861. AT TIME 49.00 HOURS

PEAK OUTFLOW IS 3613. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5169. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 6679. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9090. AT TIME 44.00 HOURS

BEGIN DAM FAILURE AT 43.00 HOURS

PEAK OUTFLOW IS 77521. AT TIME 43.52 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

CHANNEL ROUTE THRU SUB AREA-4

ISTAQ	ICOPP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

SA(1)	SA(2)	SA(3)	ELMVT	ELMAX	RLNTH	SEL
0.0600	0.0400	0.0600	1113.0	1130.0	10000.	0.00010

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

```
      100.00 1120.00 2200.00 1120.00 2230.00 1115.00 2240.00 1113.00 2250.00 1113.00
     2260.00 1115.00 2500.00 1120.00 2900.00 1130.00

STORAGE      0.00      2.97      7.78     16.79     35.49     64.11    102.65    151.11    210.43
           501.98    755.16   1080.05   1476.56   1944.71   2477.49   3026.73   3583.33   4147.27

OUTFLOW      0.00      3.72     14.26     36.81     76.44    138.15    226.71    346.41    489.73
          1034.29   1520.74   2196.50   3093.00   4239.36   5780.32   7737.05   9960.63  12440.01

  STAGE   1113.00   1113.89   1114.79   1115.68   1116.58   1117.47   1118.37   1119.26   1120.16
          1121.95   1122.84   1123.73   1124.63   1125.52   1126.42   1127.31   1128.21   1129.10

   FLOW      0.00      3.72     14.26     36.81     76.44    138.15    226.71    346.41    489.73
          1034.29   1520.74   2196.50   3093.00   4239.36   5780.32   7737.05   9960.63  12440.01

MAXIMUM STAGE IS    1120.9

MAXIMUM STAGE IS    1123.1

MAXIMUM STAGE IS    1124.6

MAXIMUM STAGE IS    1124.7

MAXIMUM STAGE IS    1125.9

MAXIMUM STAGE IS    1129.9

MAXIMUM STAGE IS    1120.9

MAXIMUM STAGE IS    1123.1

MAXIMUM STAGE IS    1124.6

MAXIMUM STAGE IS    1124.7

MAXIMUM STAGE IS    1125.9

MAXIMUM STAGE IS    1129.6

MAXIMUM STAGE IS    1120.9

MAXIMUM STAGE IS    1123.1

MAXIMUM STAGE IS    1124.6

MAXIMUM STAGE IS    1124.7

MAXIMUM STAGE IS    1125.9

MAXIMUM STAGE IS    1128.7
```

MAXIMUM STAGE IS 1120.9

MAXIMUM STAGE IS 1123.1

MAXIMUM STAGE IS 1124.0

MAXIMUM STAGE IS 1124.7

MAXIMUM STAGE IS 1125.9

MAXIMUM STAGE IS 1126.7

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

SUB AREA-4 RUNOFF

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.51	0.00	8.21	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	19.50	111.00	123.00	133.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.000

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 3.72 CP=0.77 NTA= 0

RECESSION DATA

STRTQ= 5.00 QRCSN= 5.00 RTIOR= 1.00

UNIT HYDROGRAPH 14 END-OF-PERIOD ORDINATES, LAG= 3.69 HOURS, CP= 0.76 VOL= 1.00

45. 149. 265. 328. 299. 210. 127. 77. 47. 29.
17. 11. 6. 4.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	22.15	18.48	3.67	30254.
										(563.)	(469.)	(93.)	(856.70)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE 2 HYDROGRAPHS AT 4

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.20	RATIO 2 0.40	RATIO 3 0.50	RATIO 4 0.60	RATIO 5 0.80	RATIO 6 1.00
HYDROGRAPH AT	1	2.54	1	883.	1765.	2206.	2648.	3530.	4413.
	(	6.58)	(	24.99)(	49.98)(	62.47)(	74.97)(	99.96)(	124.95)(
			2	883.	1765.	2206.	2648.	3530.	4413.
			(	24.99)(	49.98)(	62.47)(	74.97)(	99.96)(	124.95)(
			3	883.	1765.	2206.	2648.	3530.	4413.
			(	24.99)(	49.98)(	62.47)(	74.97)(	99.96)(	124.95)(
			4	883.	1765.	2206.	2648.	3530.	4413.
			(	24.99)(	49.98)(	62.47)(	74.97)(	99.96)(	124.95)(
ROUTED TO	2	2.54	1	831.	1686.	2111.	2538.	3408.	4264.
	(	6.58)	(	23.53)(	47.73)(	59.79)(	71.86)(	96.49)(	120.75)(
			2	831.	1686.	2111.	2538.	3408.	4264.
			(	23.53)(	47.73)(	59.79)(	71.86)(	96.49)(	120.75)(
			3	831.	1686.	2111.	2538.	3408.	4264.
			(	23.53)(	47.73)(	59.79)(	71.86)(	96.49)(	120.75)(
			4	831.	1686.	2111.	2538.	3408.	4264.
			(	23.53)(	47.73)(	59.79)(	71.86)(	96.49)(	120.75)(
HYDROGRAPH AT	2	2.36	1	920.	1840.	2300.	2760.	3680.	4600.
	(	6.11)	(	26.05)(	52.10)(	65.13)(	78.15)(	104.20)(	130.25)(
			2	920.	1840.	2300.	2760.	3680.	4600.
			(	26.05)(	52.10)(	65.13)(	78.15)(	104.20)(	130.25)(
			3	920.	1840.	2300.	2760.	3680.	4600.
			(	26.05)(	52.10)(	65.13)(	78.15)(	104.20)(	130.25)(
			4	920.	1840.	2300.	2760.	3680.	4600.
			(	26.05)(	52.10)(	65.13)(	78.15)(	104.20)(	130.25)(
2 COMBINED	2	4.90	1	1676.	3390.	4257.	5114.	6874.	8602.
	(	12.69)	(	47.45)(	95.99)(	120.54)(	144.82)(	194.66)(	243.59)(
			2	1676.	3390.	4257.	5114.	6874.	8602.
			(	47.45)(	95.99)(	120.54)(	144.82)(	194.66)(	243.59)(
			3	1676.	3390.	4257.	5114.	6874.	8602.
			(	47.45)(	95.99)(	120.54)(	144.82)(	194.66)(	243.59)(
			4	1676.	3390.	4257.	5114.	6874.	8602.
			(	47.45)(	95.99)(	120.54)(	144.82)(	194.66)(	243.59)(
ROUTED T	3	4.90	1	1240.	2502.	3137.	3771.	5050.	6326.
	(	12.69)	(	35.10)(	70.85)(	88.83)(	106.79)(	143.00)(	179.14)(
			2	1240.	2502.	3137.	3771.	5050.	6326.
			(	35.10)(	70.85)(	88.83)(	106.79)(	143.00)(	179.14)(

			3	1246.	2502.	3137.	3771.	5050.	6326.
				(35.10)(	70.85)(	88.83)(	106.79)(	143.00)(	179.14)(
			4	1240.	2502.	3137.	3771.	5050.	6326.
				(35.10)(	70.85)(	88.83)(	106.79)(	143.00)(	179.14)(
HYDROGRAPH AT	3	3.31	1	1310.	2621.	3276.	3931.	5241.	6552.
		(8.57)		(37.10)(	74.21)(	92.76)(	111.31)(	148.42)(	185.52)(
			2	1310.	2621.	3276.	3931.	5241.	6552.
				(37.10)(	74.21)(	92.76)(	111.31)(	148.42)(	185.52)(
			3	1310.	2621.	3276.	3931.	5241.	6552.
				(37.10)(	74.21)(	92.76)(	111.31)(	148.42)(	185.52)(
			4	1310.	2621.	3276.	3931.	5241.	6552.
				(37.10)(	74.21)(	92.76)(	111.31)(	148.42)(	185.52)(
2 COMBINED	3	8.21	1	2260.	4547.	5697.	6847.	9154.	11467.
		(21.26)		(64.00)(	128.76)(	161.32)(	193.89)(	259.20)(	324.70)(
			2	2260.	4547.	5697.	6847.	9154.	11467.
				(64.00)(	128.76)(	161.32)(	193.89)(	259.20)(	324.70)(
			3	2260.	4547.	5697.	6847.	9154.	11467.
				(64.00)(	128.76)(	161.32)(	193.89)(	259.20)(	324.70)(
			4	2260.	4547.	5697.	6847.	9154.	11467.
				(64.00)(	128.76)(	161.32)(	193.89)(	259.20)(	324.70)(
ROUTED TO	100	8.21	1	861.	3613.	5189.	6679.	9090.	49393.
		(21.26)		(24.38)(	102.32)(	146.93)(	189.11)(	257.40)(	1398.66)(
			2	861.	3613.	5189.	6679.	9090.	39686.
				(24.38)(	102.32)(	146.93)(	189.11)(	257.40)(	1123.77)(
			3	861.	3613.	5189.	6679.	9090.	37559.
				(24.38)(	102.32)(	146.93)(	189.11)(	257.40)(	1064.68)(
			4	861.	3613.	5189.	6679.	9090.	37105.
				(24.38)(	102.32)(	146.93)(	189.11)(	257.40)(	1050.71)(
ROUTED TO	4	8.21	1	668.	1753.	2487.	3222.	4843.	14969.
		(21.26)		(18.93)(	49.63)(	70.41)(	91.23)(	137.13)(	423.87)(
			2	668.	1753.	2487.	3222.	4843.	12043.
				(18.93)(	49.63)(	70.41)(	91.23)(	137.13)(	341.02)(
			3	668.	1753.	2487.	3222.	4843.	11451.
				(18.93)(	49.63)(	70.41)(	91.23)(	137.13)(	324.26)(
			4	668.	1753.	2487.	3222.	4843.	11309.
				(18.93)(	49.63)(	70.41)(	91.23)(	137.13)(	320.22)(
HYDROGRAPH AT	4	2.31	1	885.	1770.	2212.	2655.	3539.	4424.
		(6.50)		(25.06)(	50.11)(	62.64)(	75.17)(	100.22)(	125.28)(
			2	885.	1770.	2212.	2655.	3539.	4424.
				(25.06)(	50.11)(	62.64)(	75.17)(	100.22)(	125.28)(
			3	885.	1770.	2212.	2655.	3539.	4424.
				(25.06)(	50.11)(	62.64)(	75.17)(	100.22)(	125.28)(
			4	885.	1770.	2212.	2655.	3539.	4424.
				(25.06)(	50.11)(	62.64)(	75.17)(	100.22)(	125.28)(
2 COMBINED	4	10.52	1	973.	2084.	3143.	4045.	6136.	18207.

(27.76)	(27.57)(	59.01)(	86.24)(	114.54)(	173.74)(	515.56)(	
2	973.	2084.	3045.	4045.	6136.	15261.	
	(27.57)(	59.01)(	86.24)(	114.54)(	173.74)(	432.72)(	
3	973.	2084.	3045.	4045.	6136.	14689.	
	(27.57)(	59.01)(	86.24)(	114.54)(	173.74)(	415.56)(	
4	973.	2084.	3045.	4045.	6136.	14547.	
	(27.57)(	59.01)(	86.24)(	114.54)(	173.74)(	411.52)(	

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	831.	1214.6	44.00
0.40	1686.	1216.1	44.00
0.50	2111.	1216.6	44.00
0.60	2538.	1217.1	44.00
0.80	3408.	1217.9	44.00
1.00	4264.	1218.7	44.00

PLAN 2 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	831.	1214.6	44.00
0.40	1686.	1216.1	44.00
0.50	2111.	1216.6	44.00
0.60	2538.	1217.1	44.00
0.80	3408.	1217.9	44.00
1.00	4264.	1218.7	44.00

PLAN 3 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	831.	1214.6	44.00
0.40	1686.	1216.1	44.00
0.50	2111.	1216.6	44.00
0.60	2538.	1217.1	44.00
0.80	3408.	1217.9	44.00
1.00	4264.	1218.7	44.00

PLAN 4 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	831.	1214.6	44.00
0.40	1686.	1216.1	44.00
0.50	2111.	1216.6	44.00
0.60	2538.	1217.1	44.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1211.00	1211.00	1216.00
STORAGE	1717.	1717.	2960.
OUTFLOW	0.	0.	1252.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	1214.9[illegible]	[illegible]	27[illegible]1.	[illegible]61.	[illegible]	49.00	0.00
0.40	1216.[illegible]	0.[illegible]	3154.	3[illegible]13.	[illegible].00	45.00	0.00
[illegible]	1216.9[illegible]	0.[illegible]	322[illegible].	5189.	10.00	45.00	0.00
[illegible]	12[illegible].23	1.2[illegible]	3269.	6679.	10.00	44.00	0.00
[illegible]	1217.[illegible]	1.[illegible]	337[illegible].	[illegible]090.	12.00	44.00	0.00
1.[illegible]	1217.[illegible]	1.[illegible]	344[illegible].	[illegible]	2.46	43.[illegible]	43.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1211.[illegible]	1211.00	1216.00
STORAGE	1717.	1717.	29[illegible]0.
OUTFLOW	0.	0.	1252.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	121[illegible]	0.[illegible]	2701.	[illegible]61.	0.00	49.00	0.00
[illegible]	[illegible]	0.69	3154.	3613.	8.00	45.00	0.00
[illegible]	121[illegible]	0.9[illegible]	322[illegible].	5189.	10.00	45.00	0.00
[illegible]	1217.2[illegible]	1.22	[illegible]	[illegible]679.	10.00	44.00	0.00
[illegible]	1217.5[illegible]	1.58	337[illegible].	4090.	12.00	44.00	0.00
[illegible]	[illegible]	1.[illegible]	344[illegible].	[illegible]484.	2.32	43.66	43.00

PLAN 3 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1211.00	1211.00	1216.00
STORAGE	1717.	1717.	2960.
OUTFLOW	[illegible]	0.	1252.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	1214.[illegible]	[illegible]	[illegible]	[illegible]61.	[illegible]	49.00	0.00
[illegible]	1216.[illegible]	0.69	3154.	3613.	8.00	45.00	0.00
[illegible]	1216.[illegible]	[illegible]	[illegible]	5189.	10.00	45.00	0.00
[illegible]	[illegible]	1.[illegible]	[illegible]	6679.	10.00	44.00	0.00
[illegible]	1217.[illegible]	1.[illegible]	[illegible]	[illegible]	12.00	44.00	0.00
[illegible]	[illegible]	1.[illegible]	[illegible]	[illegible]2.	2.2[illegible]	43.5[illegible]	43.00

[illegible] ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1211.00	1211.00	1216.00
STORAGE	1717.	1717.	2920.
OUTFLOW	0.	0.	1252.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	1214.[illegible]	0.00	2701.	[illegible]61.	0.00	49.00	0.00
[illegible]	1216.[illegible]	0.69	3154.	3613.	8.00	45.00	0.00
[illegible]	121[illegible]	0.[illegible]	32[illegible].	51[illegible]9.	10.00	45.00	0.00
[illegible]	1217.[illegible]	1.[illegible]	[illegible]	[illegible]67[illegible].	10.00	44.00	0.00
[illegible]	1217.5[illegible]	1.5[illegible]	[illegible]37[illegible].	[illegible]	12.00	44.00	0.00
[illegible]	1.[illegible]	1.[illegible]	344[illegible].	[illegible]521.	2.24	43.52	43.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	[illegible]6.	1120.9	54.00
0.40	1753.	1123.1	50.00
0.50	24[illegible]7.	1124.0	49.00
0.60	3222.	1124.7	48.00
[illegible]	4[illegible]43.	1125.9	4[illegible].00
1.00	14[illegible].	11[illegible]	45.00

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	[illegible].	1120.9	54.00
0.40	1753.	1123.1	50.00
0.50	2427.	1124.0	49.00
0.60	3222.	1124.7	48.00
0.80	4[illegible].	1125.9	4[illegible].00
1.00	12643.	1127.0	45.00

PLAN 3 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	[illegible].	1120.9	54.00
0.40	1753.	1123.1	50.00
[illegible]	24[illegible].	1124.0	4[illegible]
0.60	3222.	1124.7	4[illegible].00
[illegible]	4[illegible].	1125.9	4[illegible].00
[illegible]	114[illegible].	112[illegible].7	45.00

[illegible] STATION [illegible]

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.20	[illegible]	1120.9	54.00
0.40	[illegible]	1123.1	50.00
0.50	24[illegible]7.	1124.0	49.00
0.60	[illegible]	1124.7	4[illegible].00
0.80	4[illegible]43.	1125.9	48.00
1.00	11[illegible]9.	112[illegible].7	45.00

APPENDIX D

REFERENCES

APPENDIX

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